ANNUAL REPORT FOR 1969

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN - 11

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CONTENTS

INTRODUCTION

The scientific work of the Institute is broadly divided into three major divisions namely, fishery biology, marine biology and oceanography and fishery resources. The work, as a whole, has a regionwise and subjectwise distribution. Apart from the headquarters at Mandapam Camp, there are nine research substations located at Bombay, Karwar, Calicut, Ernakulam, Madars, Mangalore, Vizhinjam, Tuticorin and Waltair and four research units at Veraval, Port Blair, Minicoy and Kakinada. In addition, 27 research and survey units are functioning at other centres spread over the entire coast-line of India.

Objectives:

The Institute has, as its main objective, investigations which would lead to the estimation and conservation of marine fishery resources of the country. For this the Institute implements research programmes in the fields of fishery survey, fishery biology and marine biology and oceanography; to assess the present level of exploitation of the fishery resources; to gather detailed information on the individual species which constitute the chief fisheries of the country; to find out means of assessing their potential for planning a better exploitation, without harming the sustaining stocks and to study such environmental factors as are likely to influence the nature and magnitude of these fisheries.

Organisational Structure:

The three main divisions of the Institute are:

1. Fishery resources;
2. Fishery biology; and
3. Marine biology and oceanography.

Library:

The library of the Institute is very well known for its collection of books and periodicals pertaining to fisheries and allied subjects. Considerable additions are being made almost continuously by exchange of publications for the Indian Journal of Fisheries, Advance Abstracts of Contributions on Fisheries and Aquatic Science in India and the Bulletin of C. M. F. R. I.

About 75 new books and 400 volumes of periodicals were added to the library during the year.

As usual, library books were sent on inter-library loans to different organizations and the library facilities were made available to several Indian and foreign scientists.

Publications:

Volume XII No. 1 (A&B) of the Indian Journal of Fisheries and vol. III Nos. 1, 2, 3 and 4 of the Advance Abstract and Nos. 2 to 15 of the Bulletin of the C. M. F. R. I. were published during the year. Report No. 1 of another new publication, 'C. M. F. R. I. Research Cruise Report' was issued. The printing of the Indian Journal of Fisheries vol. XII No. 2 and vol. XIII No. 1 and the 'Proceedings of the Symposium on the living resources of the Seas around India' is in progress.

A list of publications by the staff of the Institute is appended at the end of the report.

List of Distinguished Visitors:

1. Dr. D. R. Stoddart, Department of Geography, Cambridge University, England.
2. Dr. Michel Pichon, Station Marine d'Endoume, Marseille, France.
3. Prof. Hans Mergner, I. Zoologisches Institute der Justus Liebing Universitaet, West Germany.
4. Dr. D. J. Tranter, National Institute of Oceanography, Cochin, India.
5. Dr. Bernard Salvat, Laboratorie de Malacologie, 55 rue Buffon, Paris 5 eme Museum National d'Histoire Naturelle, France.
6. Dr. Peter W. Glynn, Smithsonian Tropical Research Institute, Panama, Canal Zone.
7. Dr. K. Werner Barthel, Bayerische Staatssammlung fur Palaontologie u. historiesche Geologie, Munich, Germany.
8. Dr. Lawrence R. Nicloskey, Systematics-Ecology Programme, Marine Biological Laboratory, Woods Hole, Mass., U. S. A.
9. Dr. M. Vannucci, Oceanographic Institute, Sao Paulo, Brazil.
10. Dr. F. R. Fosberg, Smithsonian Institution, U. S. National Museum, Washington, U. S. A.
11. Dr. R. Serene, National Museum, Stamford Road, Singapore-6.
12. Dr. J. P. Chevalier, Museum National d'Histoire Naturelle, Paris, France.
13. Dr. Michel Denizot, Museum d'Histoire Naturelle, Paris, France.
14. Dr. Sukarno, Institute of Marine Research, Djakarta, Indonesia.
15. Dr. Cristopher J. Bayne, Museum of Zoology, University of Michigan, Ann Arbor, Michigan, U. S. A.

16. Dr. Ernst Kirsteuer, Department of Living Invertebrates, American Museum of Natural History, New York, U. S. A.

17. Dr. Klaus Rutzler, Department of Invertebrate Zoology, Museum of Natural History, Smithsonian Institution, Washington, U. S. A.

18. Dr. Rodolfo Ramirez, Secretaria de Marina, Mexico, Solola 596, Mexico.

19. Dr. Yves B. Plessis, Museum National d'Histoire Naturelle, Paris, France.

20. Dr. Gerald J. Bakus, Allan Hancock Foundation, University of Southern California, Los Angeles, California, U. S. A.

21. Dr. F. H. Talbot, Australian Museum, Sydney, Australia.

22. Mrs. and Dr. George Scheer, Zoological Department, Hessian State Museum, Darmstadt, Germany.

23. Dr. R. E. Johannes, Department of Zoology, University of Georgia, Athens, Georgia, U. S. A.

24. Shri H. G. Vartak, Minister for Food, Civil Supplies and Fisheries, Maharashtra.

25. Col. V. V. Dev, Chairman, Marine Products Export Promotion Council, Cochin-16.

26. Col. Hla Aung, Director-General Burma Survey Department, Rangoon, Burma.

27. Shri J. S. Paintal, Surveyor-General of India.

28. Shri J. L. Hathi, Union Minister for Labour and Rehabilitation, New Delhi.

29. Shri V. Nanjappa, Secretary, Department of Rehabilitation, Ministry of Labour, Employment and Rehabilitation, New Delhi.

30. Shri S. M. Mohamed Sheriff, Member of Lok Sabha.

31. Shri D. Ering, Union Deputy Minister for Food, Agriculture, Community Development and Co-operation, New Delhi.

32. Mr. M. J. B. Lowe, Assistant Representative, British Council, Madras.

33. Mr. Hon'ble M. Natesan, Judge, High Court of Madras.

34. His Highness the Maharajah Jamsaheb of Nawanagar, Jamnagar.

Obituary:

Shri V. Ekambaram, Laboratory Attendant, who has been serving in this Institute at the Madras Substation, expired on 11-4-69 at his residence after a brief illness.

Research Collaboration with Other Institutes and Universities:

1. Underwater research at Tuticorin in collaboration with the State Fisheries Departmeat of Tamil Nadu.
2. Indo-Norwegian Project, Govt. of India.
3. Deep Sea and Offshore Fishing Stations, Govt. of India.

Fellowships, Studentships:

There were 5 research scholars undergoing training at this Institute under the scheme of Scholarships extended to them by the Government of India.

Shri P. A. Thomas, formerly working as a Research Scholar and presently working as Senior Research Assistant in this Institute had submitted his thesis entitled "Studies on Sponges" as indicated in the previous report. He has since been awarded the degree of Ph. D., by the University of Kerala.

Advisory Service Received and Provided:

1. Dr. S. Jones, Director, served as a Member in the Madras State Fisheries Research Council, Kerala State Fisheries Research Committee and Kerala State Fisheries Advisory Board.

2. Shri S. K. Banerji, Fishery Scientist, served as a Memebr of Board of Studies in Fisheries of the Calicut University, and Examiner for qualifying examination for Diploma in Fisheries Science of the Central Institute of Fisheries Education, Bombay.

3. Shri K. Virabhadra Rao, Fishery Scientist, served as a Member of the Board of Question Paper Setters and Examiners of the Kerala University; and Examiner for Ph. D. degree examination of the Annamalai University, Tamil Nadu.

4. Dr. G. Seshappa, Fishery Scientist, served as a Member of the Board of Studies in Fisheries of the Calicut University.

Finance:

The budget allotment of this Institute for the financial year ending 31.3.1970 has been Rs. 9,76,500/- under Plan and Rs. 27,08,500/- under Non-Plan.

Conference and Symposia:

The Symposium on 'Corals and Coral Reefs' conducted by the Marine Biological Association of India was held in the Institute from 12 to 16 January, 1969.

Appointments:

The following appointments to the posts equivalent to gazetted status were made during the year.

1. Dr. B. Krishnamoorthi as Junior Fishery Scientist.
2. Shri S. K. Dharmaraja as Assistant Fishery Scientist.
3. Shri M. S. Rajagopalan, Do.
4. Shri P. Bensam, Do.
5. Shri P. Sam Bennet, Do.
6. Dr. K. Satyanarayana Rao, Do.
7. Shri A. Noble, Do.
8. Shri M. Kumaran as Curator.
9. Shri S. Subramanian as Accounts Officer.

FISH RESOURCES STUDIES

The total landings of marine fish in India during 1969 were estimated at 913,630 tonnes as against 934,611 tonnes in 1968. The statewise break-up of the total landings for 1969 and 1968 is given below:

TABLE I

Statewise marine fish landings

	State	Landings in tonnes 1969	1968
1.	West Bengal & Orissa	22,879	30,658
2.	Andhra	77,526	77.429
3.	Tamil Nadu	151,876	154,400
4.	Pondicherry	10,637	8,151
5.	Kerala	294,787	345,301
6.	Mysore	75,793	87,822
7.	Goa	27,559	18,888
8.	Maharashtra	168,720	123,916
9.	Gujarat*	82,248	86,585
10.	Andaman Islands	412	341
11.	Laccadive Islands	1,193	1,120
	Total	913,630	934,611

* Excluding the Kutch coast for which data are not available.

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* Excluding the Kutch coast for which data are not available.

It will be seen from the above table that the total landings of marine fish in India recorded a decrease of above 21,000 tonnes (2%) during 1969, as compared to those of the last year. Excepting Andhra, Pondicherry, Maharashtra and Goa all the maritime States of India registered reduced landings. While the catch in Andhra was more or less the same as that in the last year, Kerala recorded significantly poor yield. Maharashtra recorded better landings. Adaman and Laccadive islands also showed increased catch.

The total landings in West Bengal and Orissa declined by about 8,000 tonnes (25%). While there was some improvement in the landings of 'lesser sardines' and 'other clupeoids', the fisheries of penaeid prawns, *Harpodon nehereus*, *Thrissocles*, sciaenids and ribbon fish suffered a decline.

There was no significant change in the total landings in Andhra. A comparatively poor yield was obtained of elasmobranchs, pomfrets, penaeid prawns, *Chirocentrus* and cat fishes. But this decline was compensated by the higher catches of lesser sardines, sciaenids, ribbon fish, *Thrissocles* and non–penaeid prawns.

A minor decrease of about 2,500 tonnes (2%) was noticed in the total landings in Tamil Nadu. The fisheries of ribbon fish, *Leiognathus*, *Chirocentrus*, *Chorinemus* and *Lactarius* registered some fall. The landings of other sardine *Anchoviella*, elasmobranchs and *Caranx*, however showed an improvement.

In Pondicherry, the total landings increased by about 30%. There was enhanced yield of *Anchoviella*, and lesser sardines.

In Kerala, a significant fall of about 50,500 tonnes (15%) was noticed in the total landings. The oil sardine fiishery was lean. Landings of oil sardine alone accounted for a decline of about 107,000 tonnes. The fisheries of mackerel, penaeid prawns, *Leiognathus*, ribbon fish and *Anchoviella* recorded higher landings.

The total landings in Mysore showed a decline of about 12,000 tonnes (14%). The oil sardine fishery suffered a set back and showed a decrease of about 20,000 tonnes. The fisheries of pomfrets and penaeid prawns were also poor. The landings of mackerel and lesser sardines, however, registered significant improvement.

In Maharashtra the total landings increased by about 45,000 tonnes (36%). The fisheries of mackerel, sciaenids, *Caranx* and penaeid praws showed improvement. The catches of ribbon fish and *Harpodon nehereus* registered some decline.

The fisheries of sciaenids, elasmobranchs and other *Hilsa* were better in Gujarat. But the landings of *Harpodon nehereus*, and penaeid prawns decreased resulting in a decline of about 4,000 tonnes (5%) in the total catch of the State.

Composition of total Marine fish landings:

Table II shows the composition of total marine fish landings in India during 1968 and 1969.

TABLE II

Composition of total marine fish landings in India during 1969 and 1968

(Quantity in tonnes)

S. No.		Name of fish	1969	1968
1.		Elasmobranchs	35,442	33,367
2.		Eels	3,052	3,422
3.		Cat fishes	26,903	24,749
4.		*Chirocentrus*	9,337	11,578
5.	a)	Oil sardine	174,249	301,641
	b)	Lesser sardines	52,467	43,450
	c)	*Hilsa ilisha*	661	797
	d)	Other *Hilsa*	7,873	7,902
	e)	*Anchoviella*	31,436	20,254
	f)	*Thrissocles*	9,009	8,245
	g)	Other clupeids	26,316	26,297
6.	a)	*Harpodon nehereus*	76,276	82,501
	b)	*Saurida* and *Synodus*	3,043	2,276
7.		*Hemirhamphus* and *Belone*	981	1,150
8.		Flying fishes	4,039	4,545
9.		Perches	12,865	10,622
10.		Red mullets	3,475	2,061
11.		Polynemids	3,480	2,819
12.		Sciaenids	35,041	28,305
13.		Ribbon fishes	31,722	28,667
14.	a)	*Caranx*	21,415	18,615
	b)	*Chorinemus*	2,443	3,450
	c)	*Trachynotus*	149	24
	d)	Other carangids	7	10
	e)	*Coryphaena*	237	247
	f)	*Rachycentron*	309	215
15.	a)	*Leiognathus*	44,038	37,887
	b)	*Gazza*	102	157
16.		*Lactarius*	4,546	6,113

TABLE II *(Contd.)*

S. No.	Name of fish	1969	1968
17.	Pomfrets	24,176	28,235
18.	Mackerel	91,837	21,703
19.	Seer fishes	11,516	13,385
20.	Tunnies	3,445	4,303
21.	*Sphyraena*	1,996	1,918
22.	*Mugil*	2,693	3,278
23.	*Bregmaceros*	1,684	1,825
24.	Soles	11,991	11,467
a)	Penaeid prawns	72,133	69,514
b)	Non-penaeid prawns	33,964	31,922
c)	Other crustaceans	5,670	4,301
25.	Cephalopods	769	1,617
26.	Miscellaneous	30,843	29,777
	Total	913,630	934,611

The salient features of the fisheries of 1969 were as follows :

1) The oil sardine fishery suffered a set back both in Kerala and Mysore. During the last five years the average annual landing of oil sardine was 268,275 tonnes. Landing in 1969 fell short of this figure by 94,026 tonnes.

2) The mackerel fishery showed a recovery after eight years. During 1961-68 the average landings of mackerel were 36,329 tonnes. In 1969 the catch of this fish outstripped this figure by 55,508 tonnes and recorded the highest yield since 1960.

3) Panaeid prawns registered better catches in Kerala and Maharashtra. Non-penaeid prawns showed an improved yield in Andhra.

4) The fishery of *Harpodon nehereus* was not so good in Maharashtra and Gujarat.

5) The fishery of *Anchoviella* showed an enhanced yield in Kerala, Tamil Nadu and Pondicherry.

6) Though there was a comparatively better fishery of pomfrets in Maharashtra and Kerala, the reduced yield of this fishery in Mysore and Andhra decreased the all India figure.

7) The landings of *Leiognathus* showed a small decline in Andhra and Tamil Nadu but in all the other maritime States of India it registered an improvement.

8) The yield of ribbon fishes decreased in Tamil Nadu, but a good landing of this fish was recorded in Kerala and Andhra.

Seasonal Variations in total landings:

Table III shows the seasonal variations in total landings in the different maritime States of India.

TABLE III

Quarterly marine fish landings in India during 1969

(Quantity in tonnes)

State	IQr.	IIQr.	IIIQr.	IVQr.	Total
W. Bengal & Orissa	7,753	2,358	4,469	8,299	22,879
Andhra	29,984	13,429	18,061	16,052	77,528
Tamil Nadu	42,432	37,247	42,210	29,987	151,876
Pondicherry	4,553	1,345	2,532	2,207	10,637
Kerala	62,623	33,550	70,189	128,425	294,787
Mysore	27,049	5,302	3,217	40,225	75,793
Goa	1,522	840	1,052	24,145	27,559
Maharashtra	26,574	34,644	6,645	100,857	168,720
Gujarat	22,774	8,506	4,221	46,747	82,248
Andamans	105	99	114	94	412
Laccadives	415	204	135	439	1,193
Total	225,784	137,524	152,845	397,477	913,630
Percentage	24.71	15.05	16.73	43.51	100.00

The above table shows that about 44% of the total all India landings took place in the fourth quarter. Along the west coast of India the bulk of the catch was landed in the fourth quarter, while along the east coast, excepting West Bengal and Orissa, the maximum catch was obtained during the first quarter.

Catch per unit effort:

The following table shows the total effort in man-hours expended in each State by the indigenous boats (both mechanised and non-mechanised) and catch in kg per man-hour. The corresponding figures for 1968 are also shown for comparison.

TABLE IV

Fishing effort in man-hours and catch in kg per man-hour

State	Effort in 1000 man-hrs		Catch in kg per man-hour	
	1969	1968	1969	1968
W. Bengal & Orissa	13,683	15,224	1.63	1.97
Andhra	30,219	35,898	2.51	2.10
Tamil Nadu	46,359	45,148	3.27	3.41
Pondicherry	3,969	3,391	2.68	2.40
Kerala	36,308	41,332	8.00	8.28
Mysore	7,608	7,214	8.84	11.49
Maharashtra	25,545	21,567	6.50	5.64
Gujarat	12,986	18,902	6.33	4.58
Total	176,677	188,676	4.91	4.77

It is seen from the above table, that the all India catch per unit effort showed some increase. While Tamil Nadu and Pondicherry expended some higher effort along the east coast of India, Maharashtra and Mysore spent more effort along the west coast of India. All other maritime states put comparatively less effort. Mysore recorded the highest yield per unit effort, followed by Kerala and Maharashtra. Gujarat recorded a higher catch per unit effort as compared to that in 1968. Along the east coast the highest yield per unit effort was in Tamil Nadu.

POPULATION STUDIES

A tentative assessment of the effect of fishing on two of our most important pelagic fisheries, namely, the oil sardine and mackerel, was completed during the year. In the case of oil sardine, the natural mortality rate M is estimated at 0.67 and the average fishing mortality rate F generated by the present intensity of fishing is estimated at 0.75. The maximum value of yield per recruit Y/R is obtained at fishing effort corresponding to $F=1.4$ but this is estimated at only about 12 per cent more than the current Y/R.

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Thus, theoretically, only about 12 per cent more yield per recruit is possible if we double our fishing effort. This indicates that not much of oil sardine could be obtained by further increase in fishing effort, so long as the fishing is restricted to inshore waters.

In the case of mackerel, the natural mortality rate M is estimated at 0.65 and the average fishing mortality rate F at 1.40. The maximum yield per recruit Y/R is obtained at F=1.55. This shows that we are almost exerting the maximum effort and are nearer to the optimum yield. Any further increase in the fishing effort in the inshore fishing areas exploited at present may fetch only a marginal increase in the catch.

FISHERY BIOLOGY INVESTIGATIONS
PELAGIC FISHERIES

Mackerel Investigations

The fishery:

The following were the total estimated landings of the Indian mackerel, *Rastrelliger kanagurta* at the different major observation centres of the west coast during the year, in comparison with the totals of the previous two years:

Centres	Estimated total landings in tonnes		
	1967	1968	1969
Karwar	526.6	215.6	890.9
Mangalore-Ullal	79.1	11.9	70.3
Mangalore-Baikampady	—	79.2	154.4
Calicut	215.5	589.0	4195.0
Cochin	59.4	15.2	52.9
Vizhinjam	14.1	21.4	91.8

These figures show that the mackerel fishery was very good in 1969, the figures for Karwar and Calicut being very high. Of the annual catches shown above, the catches of the first half of the year were extremely poor, those of the second half of the year totalling up to 890.5, 68.9, 153.8, 4149.6, 50.9 and 84.5 metric tons at Karwar, Ullal, Baikampady, Calicut, Cochin and Vizhinjam respectevely.

The *Rampan* was, as usual, the net used at Karwar for the mackerel. At Ullal the *Rampan* catch of the half-year ending December was 44.48 m. tons; the *Pattabale* and the castnet landed 19.98 and 1.40 metric tons respectively while the *Kanthabala* landed only 67 kg for

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the half-year. At Baikampady the catches were better than at Ullal with a total of 153.8 metric tons in the second half of the year as against 79.2 metric tons during the second half of 1968; 134.4 metric tons of this was landed by the *Rampan* units and the rest by *Pattabale*. At Calicut the mackerel catch of the July-December period was made by the *Pattenkolli* and *Ayilachalavala*, the former yielding most of the catch. At Cochin there was no fishery exclusively for the mackerel, but the catch of the July-December period was better than during the corresponding period of 1968, the main gear being the *Thanguvala*, though the highest catch per unit was obtained in the *Aytlavala*. Vizhinjam reported a nearly fivefold increase in the mackerel catches of the July-December period of 1969 as compared to the same period of 1968. The best monthly catches at the different centres during 1969 were as follows:

Centres		Best month	Quantity (tonnes)
Karwar		November	544.4
Mangalore	Ullal	December	43.1
	Baikampady	November	92.7
Calicut		September	1711.8
Cochin		August	26.6
Vizhinjam		September	63.4

Length-frequencies:

In the January-June period, the size-range in terms of the total length, for the entire west coast was 113-274 mm, both the extreme sizes being reported from Karwar. Smaller juveniles below 150 mm did not occur in the Mangalore area and sizes above 250-265 mm did not occur in any centre on the west coast other than Karwar. Juveniles of 120 mm and above occurred at Calicut and Cochin from May onwards. The total length-ranges, and the modal sizes noticed at the different centres during different parts of the year are shown below:

Centres	Months	Range (mm)	Modes (mm)
Karwar	January 1969	190-239	200-204
	June	130-274	175-189
	August & September	80-264	180-220 mm group
	October-December	150-264	formed 97.5% in total.
Ullal	August - *Castnet*	95-145	115
	September - *Pattabale*	205-240	220
	October - ,,	180-240	205
	December - *Rampani*	170-215	210

Baikampady	January	,,	190-210	195
	February	,,	210-235	215
	September	,,	115-180	145
	,,	*Katrampani*	95-140	120
	October –	*Rampani*	160-205	200
	November	,,	170-215	200
	December	,,	180-220	210
Calicut	March		180-229	205-214
	April		200-229	205-214
	May		120-155	140-144
	June		120-264	130-149 & 230-234
	July		—	130-134
	August		—	140
	September–December		180-230	*Pattenkolli* samples showed modes at 190 in Sept., 200 in Oct. and 210 in Nov. and December
Cochin	January		200-230	210
	February		200-225	215
	March		210-225	215
	June		125-185	150
	July		90-210	130 & 175
	August		115-200	165
	September		160-210	195
	October		190-215	200
	November		190-220	210
	December		200-225	210
Vizhinjam	March & April		240-260	—
	May & June		140-160	—
	August		115-174	120-124, 135-139 & 165-169 in boat-seine catches.
	September (boat seine)		135-164	145-149
	September (shore seine)		140-199	155-159 & 180-184
	October (shore seine)		140-224	145-149, 185-189, 195-199, 205-209, & 215-219.
	December (shore seine)		80-239 (up to 299 mm in drift net)	200-204 & 220-224

The extreme range for the west coast during the second half year was 50-299 mm, the smallest size coming from Mangalore and the largest from Vizhinjam. Two unconnected size-series were observed at all centres considering the half-year as a whole.

At Mandapam the fishery of the second half of the year (1969) was supported by the juveniles, medium sized fish and adults, of which, the last two categories contributed the bulk of the landings. The length ranged from 100 mm to 295 mm with dominant groups at 120-185 mm, 200-230 mm and 235-265 mm.

The dominant size trends in the fishery of the west coast seem to be more or less comparable to those of the previous years so that it would appear that it was the second year-class that contributed the bulk of the fishery. The peak catch at Calicut in September has, however, taken a toll of the smaller of these commercial sizes while the peak month at Karwar (November) contributed to the normal sizes of the period (180-220 mm class, forming the great majority). During 1968 also it was the second year class that formed the mainstay of the fishery, as is normal with *R. kanagurta* in our waters.

Sex and maturity conditions:

Second half-year: At Karwar in August 75% of the specimens examined were in stage V and 25% in stage VI; in September the maturity stages noticed were I, II and VII. In October the specimens were all in stages I or II, while in November and December only stage I was noticed.

At Mangalore most of the samples of the first quarter were immature and stage II was dominant in the second quarter; stage VII occurred in 80% of the specimens examined from the *Pattabale* catches at Baikampady in September, this stage being not found at other centres or in other months in this locality. At Calicut in July the catches were dominated by indeterminate and spent fish, with a small number of specimens in stage I also; in August fish in stage II were found in good numbers and in September the catches contained fish with gonads in stage III also; stage I was totally absent by December; spent mackerel were recorded only up to the end of September. At Cochin all specimens examined were in stage I of maturity up to October; in November 4% were in stage II, while in December the percentage of stage II individuals increased to 10%. At Vizhinjam in september only stage I was noticed in all sizes from all gears and depths; stages I-VII were seen in October with stage III dominant; in November stages I-III occurred with II and III as the dominant ones; in December stages I to IV occurred with stage II being dominant in the shore-seine catches and stages II-III in the drift net catches.

First half year: The Karwar samples in January consisted of stages I, II and III; inJune the specimens examined were again mostly in stages I, II and III, but some individuals were in stages V and VII. Spent and spent-II was recovering females were found at Baikampady in February, while only stage found in the neighbouring Mulki during April. At Calicut good numbers of spent or partially spent individuals occurred in March and again in June, juveniles - mostly indeterminates - were dominant during the rest of the second quarter. At Cochin 57% of the mackerels were in stage I in January, and 91% in stage II by February; 50% were in stage III in March; the rest being in stages IV and V. In May at this centre, the larger specimens were in stages III, IV and V and the juveniles in stage I. At Vizhinjam during this period the two sexes were more or less equally represented in the larger size groups, the stages of maturity ranging from III to V; a large percentage were spent; and indeterminate juveniles were again dominant among the smaller sizes.

At Mandapam in the second half-year, stages V, VI and VI (b) were predominant in July and August; in the remaining months of the half-year stages VII and II were dominant. Juveniles and medium sizes were in stage I as expected.

The maturity trends noticed on the west coast were thus more or less according to the expectations, except at Calicut. Two maturity groups were encountered in the stocks in the second half-year, the small juveniles appearing in the second part of the half-year; the occurrence of these juveniles was however, rather early at some centres in the year, as normally such small sizes appear only during the monsoon months (June to September).

Other studies:

Observations on the food and feeding habits on the species at the different centres were continued. Studies on the scales were also continued. Some limited progress was possible in the tagging programme at different centres; there being very few recoveries of already tagged mackerel. The tagging done during the year included 7 specimens at Cochin and 84 at Waltair (Visakhapatnam).

Oil Sardine Investigations:

The fishery:

The oil sardine fishery in 1969 was comparatively poorer than in 1968 at all the centres, the best catches reported being at Calicut. The quarterly landings during 1969 and the annual landings during 1968 and 1969 are given in Table V and VI respectively.

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TABLE V

Quarterly oil-sardine landings (in tonnes) in 1969

Centres	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Total
Karwar	12.00	Nil	3.70	176.10	191.80
Mangalore (Ullal)	Nil	Nil	16.55	20.46	37.01
Mangalore (Baikampady)	79.27	1.93	29.12	137.52	247.84
Calicut (Vellayil)	2120.34	343.72	1390.49	5580.43	9,434.98
Cochin (Manasseri)	417.03	182.32	295.46	796.55	1,691.36
Vizhinjam	Nil	Nil	Nil	0.62	0.62

TABLE VI

Annual oil-sardine landings (in tonnes) during 1968 and 1969

Centres	1968	1969
Karwar	651.40	191.80
Mangalore (Ullal)	392.12	37.01
Mangalore (Baikampady)	379.95	247.84
Calicut (Vellayil)	12438.71	9434.98
Cochin (Manasseri)	1966.29	1691.36
Vizhinjam	0.62	0.62

At Karwar, *Rampani* and *Yendi* accounted for the entire oil sardine landings. At Mangalore, oil sardine fishery started at the southern centres during the last week of July and by the middle of August the fishery had extended to the northern centres also. While cast-net and *Rampani* were the main gears operated at Ullal, *Rampani*, *Kairampani* and *Chalabale* accounted for the oil sardine landings at Baikampady, where *Rampani* alone landed about 90% of the catches. At Calicut, *Pattenkolli* was responsible for the bulk of the catch and small quantities were landed by the *Mathichalavala*. At Cochin, the boat-seine *Thanguvala* was the main gear which landed oil sardine.

Length frequency studies:

At Karwar, in the *Rampani* samples from Karwar proper, the size-range was 107–138 mm with the mode at 120 mm in January. In the neighbouring Arge village, the size-range was 113–131 mm with two

modes, one at 115 mm and the other at 125 mm. During the last quarter of the year, the size ranged from 58 to 169 mm with modes at 75 mm in September, 110 and 130 mm in October, 135 mm in November and 120 mm in December. In the Belamber village, two modes were noticed at 110 and 170 mm. At Baikampady, in January, the size-range was 110 and 169 mm with two modes at 130 and 140 mm. In May, the size ranged from 130 to 194 mm with a single mode at 150 mm. During the period July-December the size-range was 45-194 mm with modes at 65, 80, 90, 109 and 115 mm in September, 115 and 170 mm in October, 105, 120, 130 and 140 mm in November and 125 mm in December. Juveniles contributed to the bulk of the catch during the period. At Ullal, the size-range was 50-184 mm with modes at 145 and 165 mm in August, 105 and 115 mm in September, 100 and 170 mm in October, 110 and 120 mm in November and 115 mm in December. Except in August when the percentage of big-sized oil-sardine was high (19%), during the rest of the period (September-December) juveniles contributed to the bulk of the catches. At Calicut, during, the January-June period, the length-range was 100-185 mm with modes at 115 mm in January, 140 mm in April and May and 155 mm in June. In February, there were two modes, one at 120 mm and the other at 170 mm. During the July-September period, the range was 50-190 mm with modes at 135 and 160 mm in July, 120 and 165 mm in August and 85 and 165 mm in September. During the last qrarter, the size ranged from 80 to 180 mm with modes at 105 and 170 mm in October and 110 and 170 mm in November. At Cochin, the size-range was 100–185 mm during the first half of the year with modes at 120 mm in January, February and April, 130 mm in March and May and 140 mm in June. During the second half of the year, the size-range was 100-190 mm, the modes being at 160 mm in July, 165 mm in August, September, October and November, and 120 mm in December.

Sex and maturity studies:

At Karwar, throughout the period, the stages noticed were I and II. In January, at Karwar itself 48.27% of the females examined were in stage I and 6.89% in stage II. At the neighbouring Arge village, 29.16% of the females were in stage I and 16.67% in stage II. During the September-December period, except during October (46.4:53.6), males outnumbered the females, the ratios being 38.6:37.9 in September, 54.9:45.1 in November and 52.3:47.7 in December. At Baikampady, in January, stages I and III were noticed, but the former stage was dominant. In May, the landings comprised exclusively of specimens in stage IV maturity. The male:female ratio was 41.3:58.7 in January and 45:55 in May. Indeterminates dominated in September and stage II in October. In November and December, the catches were composed of indeterminates and stage I, the latter dominating with a high percentage of 89.1 and 90.4 respectively. The sex ratios in October, November and December were 43.3:56.7, 45.9:43.3 and 32.4:55.4 respectively. At Ullal, while stage VIIa dominated in August,

indeterminates supported the landings in September. The catches were composed exclusively of stage II in october and juveniles in November and December, the ratios during these three months being 41.7:58.3,58.3:34.8 and 34.0:48.0 respectively. At Calicut, the major portion of the oil-sardine catch during the first two months of the year consisted of indeterminates, only the larger specimens above 150 mm showing distinct gonad stages. However, fish examined from April to June showed clear sexual differentiation of the gonads. Indeterminates were few after April. In general, a slight increase in the females over males was noticed during all the months from January to June. Stages I and II dominated in April and May. Stage III was seen in June. During the second half of the year, except in July when the males dominated, no significant difference in the sexes was noticed during the rest of the period. At Cochin, from January to April, stage I was dominant. In May the fish were mostly in stages II to IV, while in June stages IV and V were predominant. In April and May a few 'spent recovering' specimens and in June 'partly spent' ones were noticed. The percentages of males and females were as follows:

January - 43.0:48.1; February - 44.7:47.2; March - 43.3:52.0; April - 46.3:51.4; May - 55.4:44.6; June - 62.5:37.5; July - 46.5:53.5; August - 50.0:50.0; September - 51.2:48.8; October - 47.0:53.0; November - 43.8:46.1; December - 28.9:44.9. The indeterminates formed 10.1% and 26.2% in November and December respectively.

At Vizhinjam, in November the sexes were distributed, in equal numbers, but in December, females dominated the males. In November and December, stage I dominated and the fish below 99 mm were in indeterminate stage of maturity.

Scale studies:

At Cochin, age determination of oil sardine was carried out by studying the scales. The number of rings noticed on the scales of different length ranges during the different quarters are given below:

Quarter	Size-range	Number of rings
January-March	140-150 mm	1
	155-165 mm	2
	170-185 mm	3
April-June	135-150 mm	1
	155-165 mm	2
July-September	145-155 mm	1
	160-170 mm	2
	175 mm	3
October-December	155 mm	1
	160-170 mm	2
	175 mm	3

Food Studies:

At Mangalore, the feeding was observed to be moderate, the dietary inclusions being copepods, *Coscinodiscus*, *Pleurosigma*, *Fragilaria oceanica*, *Prorocentrum micans* and green detritus. At Cochin, feeding was average from January to March. The intensity grew from poor to average from April to June, but from July to September, it was average. In the final quarter, the intensity was slightly below average. The food items noticed were copepods, tintinnids, *Coscinodiscus*, *Pleurosigma*, *Nitzchia*, *Biddulphia*, nauplii and crustacean remains.

Tagging:

Tagging and release operations were continued at Karwar, Mangalore and Cochin. In spite of repeated attempts made at Karwar, live material from the impounted catches could not be obtained. A total of 1125 oil sardine was tagged and released at Mangalore and Cochin, 200 at the former and 925 at the latter centre.

Studies on Lesser Sardines:

Madras:

During the year under review, preliminary investigations were carried out on total landings, size-pattern, food and feeding habits and maturity of *S. fimbriata* landed at Ayodhakuppam. Particular stress was laid on the availability of material, environmental features and on the methods of study. It was seen that the season for *S. fimbriata* fishery at Ayodhakuppam, Madras, during the year was from August to February.

Vizhinjam:

The various aspects of the biology of *S. sirm* (Walbaum) and *S. gibbosa* (Bleeker) have been studied in detail. Seasonal fluctuations of these species have also been observed in relation to different types of gears. The total production of *S. fimbriata* of Vizhinjam area has been assessed in relation to various types of gears. Information on some aspects of the biology has been collected.

INVESTIGATIONS ON OTHER FISHES

1. The Sciaenid fisheries:

(a) At Tuticorin:

Samples were taken from the landings of indigenous fishing craft. Small quantities of *Pseudosciaena diacanthus*, *P. aneus*, *P. coitor*, *P. sina*, and *Otolithes argenteus* were available. *Pseudosciaena soldado* and *P. coibor* were also available but even stray specimens of *Sciaena macroptera* were not available; fully mature specimens of this species were recorded from some

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estuaries. Osteological studies on *Johnius maculatus* were taken up and the juveniles of some species were studied on a comparative basis.

The catches of privately owned trawlers were also examined during the second quarter, in addition to the indigenous gears. *Otolithes argenteus*, *Pseudosciaena aneus* and *P. diacanthus* contributed to the bulk of the catches of these gears. *O. argenteus* was taken up for a detailed work. From July onwards the commercial catches of this species were dominated by two size-groups, one of about 175 mm and the other of about 225 mm. Most of the specimens examined were in maturity below stage III, only one individual being in stage III. Majority of the stomachs revealed large quantities of remains of *Anchoviella*, *Thrissocles*, *Leiognathus* and small prawns.

(b) At Calicut:

Some work was continued on the biology of *Pseudosciaena sina*, which included the observations on length frequencies, gonad condition and stomach analysis. All the 34 specimens examined in the first half year were immature. About 330 specimens belonging to seven species were examined during the second half year, the species being *Pseudosciaena sina*, *P. axillaris*, *P. soldado*, *Otolithes ruber*, *Johnius belengeri*, *J. carutta* and *Sciaena dussumieri*. Most of the specimens of *P. sina* examined had empty stomachs while some stomachs contained remains of prawns, *Squilla* sp., mysids and nereid polychaetes. Stage V of gonad maturity was frequent in November-December, and a few juveniles occurred in the collections towards the end of December. *P. axillaris* had length-range of 112–141 mm; most of the specimens being in stage II of maturity and with empty stomachs. Only a few specimens of *P. soldado* were available and these were in the length-range of 122-143 mm. *O. ruber* ranged in length from 137 to 251 mm; specimens with spent recovering ovaries were noticed in July while in November-December stages III-IV were noticed. Gut-contents included remains of prawns *(Parapenaeopsis stylifera)* and teleost fish *(Stolephorus)*. *J. belengeri* ranged in length from 112 to 193 mm and *J. carutta* from 105 to 180 mm. Only two specimens of *S. dussumieri* were available for examination.

(c) At Madras:

Work was started on *Pseudosciaena sina*, *P. vogleri* and *P. aneus* in 1969, during the second half of the year. Larger *P. sina* in the size-range of 144-175 mm were partially spent; while most of the stamachs were empty (especially in the case of the trawl catches) anchovy remains formed the food items when stamachs were full. *P. vogleri* had a length range from 110 to 206 mm those in the 110-130 mm group being immature; while fishes above that range were partially spent. One completely spent specimen was also collected in October. The stomachs of all specimens of *P. vogleri* examined were empty. *P. aneus* was immature upto a length of 120 mm and at 140 mm it was still in stage I of gonad maturity.

2. The ribbon fish fisheries:

a) At Madras: *First half year*: Observations were made at Royapuram, Triplicane and Ayodhiyakuppam centres Madras and also at Pondicherry and Nagapattinam. The ribbon fish fishery which started declining in the first quarter came to a close in the second quarter. Stray individuals of ribbon fish were obtained in the offshore catches. Data from Nagapatinam and Pondicherry were collected only in the first quarter. The length frequency analysis of *Trichiurus lepturus* obtained during the first quarter revealed that there were two prominent modes, at 100-200 mm and at 800-900 mm. The gonads of fishes examined during the first quarter revealed that they were in spent recovering stages and the stomach contents consisted of anchovies and prawns.

Second half year: In Madras the fishery for *T. lepturus* started in July after a decline in the earlier period. The catches were relatively low in the first quarter but improved in the second quarter, being better during October and November . The total monthly landings were 434 kg in August, 9180 kg in October and 10880 kg in November at Royapuram. In Triplicane and Ayodhiakuppam together the catch was 800 kg in July, 1362 kg in August, 32964 kg in October, 31974 kg in November and 13620 kg in December. A marked difference in the size composition of the fish was also seen between the first quarter of the half year 1969 as compared to the corresponding period in 1968; smaller sizes being less frequent in the year 1968. The size range in 1969 was 121-376 mm in July, 135-556 mm in August, 320-491 mm in October and 211-611 mm in November; the modes were in the groups of 100-200 mm in July, 300-400 mm in August, 300-400 mm in October and 500-600 and 600-700 mm in November.

b) At Tuticorin: *First half-year: Eupleurogrammus intermedius* and *Lepturacanthus savala* predominated the landings of the first quarter that is, January-March period; during the April-June quarter *E. intermedius* and *Trichiurus lepturus* formed the ribbon fish landings. The size of *E. intermedius* from the gill net landings was 305-485 mm with a mode at 380-389 mm; in the shore-seine landings the size-range was 270-372 mm the mode being at 300-309 mm. The majority of specimens examined were in stages II-III of maturity with a few in stage IV. The feeding intensity appeared to be high during the period, the main food items being clupeoid fish, juvenile leiognathids and prawn remains. *L. savala* was available only in the first quarter, and as stray specimens in the second quarter. It ranged in sizs from 395 mm to 515 mm in the gill net landings while in the shore-seine landings the range was 353-555 mm. Indeterminate specimens dominated all the samples. Feeding intensity was poor and the food included clupeoid fish, leiognathids (juveniles), juvenile sciaenids, juvenile squids and prawn remains. *T. lepturus* which was absent during the first quarter, but available in the second quarter in small numbers from gill nets and shore-seines. The size range was 320-489 mm in gill net samples and 180-589 mm in shore-seine samples. The gill net samples had a dominant

mode at 430-439 mm which were largely of indeterminates. A single female was found to be in stage III of maturity. The shore-seine samples showed stages II-IV of maturity and had a high feeding intensity; the gil-net samples showed poor feeding intensity and the main food item was *Anchoviella* sp. In the second half-year, the samples mainly collected from the sardine gill nets and shore seines; gill nets bringing *Trichiurus lepturus* and *Lepturacanthus savala;* and the predominant species in the shore-seine being *Eupleurogrammus intermedius*. The species showed the dominant group at 340-349 mm. Feeding intensity appeared to be moderate; the fishes mainly were found to be feeding on clupeoid fishes. Advanced stages of gonad maturity were not noticed during the half-year. In the case of *T. lepturus*, larger specimens were noticed during the second quarter, the dominant groups being of 700-709 mm and of 760-769 mm. High feeding intensity was observed during the first quarter. The fishes of this species also were mainly feeding on clupeoid fishes. Landings of *L. savala* were not as much as of the other Trichiurids during the period; the domidant group of 460-469 mm was observed in the gill net landings. In shore-seines only stray specimens were found. Feeding intensity appeared to be high, the main food items being *Anchoviella* sp; and silver bellies. Most of the specimens examined were indeterminates, some were in stages I and II.

c) At Kakinada: Ribbon fish catches at Dummulapeta were poor due to non operation of boat-seines and formed less than 4% of the total fish catch in any month. At Uppada the ribbon fish catches were fairly good; particularly in April and May they formed 26.92% and 39.97% of the total fish catch. At the Kakinada fishing harbour, the mechanised trawlers landed 0.12 to 3.09 kg of ribbon fish per hour of trawling during different months; on the whole *T. lepturus* formed more than 75% of the ribbon fish catch. Biological observations on size-range, modal sizes and occurrence of maturity stages during different months of the year for this species are given below:

Month	*Size-range* (mm)	*Modes* (mm)	*Maturity stages*
January	190-937	340,420 & 700	I, II, III, IV & V
February	227-950	380 & 740	I, II, III, IV, V & VII
March	254-1042	420 & 740	I, II, III, IV & VII
April	160-1115	260 & 740	—do—
May	143-964	180 & 700	I, II, III, IV, V & VII
June	202-842	380 & 500	—do—
July	350-780	460	Males: I, II, III, IV & VII
			Females: I, II, IV & VII
August	143-680	280 & 540	Males: I, II, III, IV & VII
			Females: I, II, III, IV, V & VII
September	118-580	220	Males: I, II & VII
			Females: I & II

October	162-612	340	Males:	I, II & VII
			Females:	No data
December	237-675	300-620	Males:	I, II, III & VII
			Females:	I, II, & VII

During the second half-year weather conditions were not conducive to fishing, particularly in October-December when a series of bay depressions resulted in less fishing effort. With the general decline of total fish catch, the ribbon fish catches also deceased. At Dummulapeta where only shore-seines and gill nets were operated, the ribbon fish catch was poor, forming less than 1.2 % of the total fish catch. At Uppada the ribbon fish catches were moderate, mainly due to the operation of boat-seines and formed 2.7 % to 36% of the total fish catch during different months. A general feature of the ribbon fish fishery at all the landing centres was the common occurrence of other species of ribbon fishes with *T. lepturus*.

(d) At Calicut: Observations were made during the first half of the year. The fishery was poor. The minimum and maximum size recorded were 155 mm and 425 mm respectively. Crustaceans and young teleosts were observed in the gut contents. A few mature specimens were noticed during March.

3. The leiognathid fisheries:

(a) At Mandapam: Work was done here on the group during the first half of the year. Observations were made on the "marks" found on the supraoccipital crest and cleithrum of *Leiognathus dussumieri;* data on the length of the fish, length of these bones and the number of marks on them were collected. Skeletons of species of the family Leiognathidae were prepared for detailed comparative osteological study. The affinity for divergence exhibited by the species with respect to some of the osteological characters were found to be of systematic significance. Systamatic study of this family was completed which showed that there are 16 species and three genera in the Indian seas. From their distributional pattern along the Indian coast, it appears that four species, namely *Leiognathus splendens, L. dussumieri, L. bindus* and *Secutor insidiator* are of fishery importance.

(b) At Calicut: Here also the work on this group was done during the first half of the year. The fishery was poor but during April and May over 14,090 Kg. were landed mostly by the mechanised boat units. The size-range of *L. bindus* varied from 32 to 54 mm. The range in the case of *L. splendens* was 34-75 mm. The modal size of *L. bindus* in April and May was 40-44 mm and that of *L. splendens* in April was 60-64 mm. Diatoms *(Fragilaria* sp. and *Coscinodiscus* sp.) and copepods were found in the gut contents of both the species. All the specimens examined were immature and indeterminates. No specimens were available in January and February.

October	162-612	340	Males:	I, II & VII
			Females:	No data
December	237-675	300-620	Males:	I, II, III & VII
			Females:	I, II, & VII

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(c) **At Madras:** *First half-year:* The landings of silver bellies in Madras coast was very poor during this period. *L. dussumieri, L. lineolatus* and *Gazza minuta* were the dominant species throughout the period. Large sized, *L. equulus* contributed in fairly good numbers in the first quarter and *L. bindus* in June. The length of *S. insidiator* in the commercial samples ranged from 23 to 97 mm, with groupings in 36-40 mm and 86-90 mm. Copepods formed the main item in the food, irrespective of the size of the fish. *Lucifer* and mysids were abundant in the stomach contents in the early part of May whereas in the later part of May and June the samples examined had empty stomachs. Mature and ripe ovaries with transparent eggs were noticed in January and February. Unlike the previous years, young juveniles of *L. insidiator* were available in plenty in February and March and a few in April and May. The ripe fish measured mostly above 80 mm.

Second half-year: The landings continued to be poor except in October and November. *L. dussumieri* and *G. minutus* were of commercial importance and formed 75% of the leiognathid catches of the Madras coast. *L. bindus, L. lineolatus* and *S. insidiator* which were obtained in good quantities during this period in 1968 were rare in the catches this year. The size range of *Secutor insidiator* examined during the July-September period was 32 to 98 mm, the dominant size-groups being 61-65 mm and 86-90 mm fork length. During October-December the size range was 54-98 mm with modes at 66-70 mm and 81-85 mm, copepods invariably formed the bulk of the gut contents. The samples examined from July to October showed that most of the fish had empty stomachs. Immature and maturing fish were recorded in July, whereas in August mature individuals were also present. Mature and ripe fishes were common in September. The majority of fish examined in October and November seemed to be spent-recovering. In December the samples contained immature, maturing and mature individuals. No post larval juveniles were recorded.

4. The anchovy fisheries:

(a) **At Visakhapatanam:** Shore-seines were operated from January to April and they landed 2.2 metric tons of *Stolephorus* sp. Boat-seines were operated from February onwards, but *Stolephorus* was landed by this net only from April to June. The total estimated landings were 19.2 metric tons. *Stolephorus* constituted one-third of the total catch of boat seines during the months of May and June. In January the shore-seine catches of *S. bataviensis* contributed to 60% of the *Stolephorus* catch and *S. heterolobus*, 40 %. In the other months the catch was exclusively composed of *S. heterolobus* only. Fish in higher length-ranges were caught in January but by March fish in smaller length-ranges entered the fishery and several modes were observed in the length-frequency data. The entry of these juveniles into the fishery persisted till June. Fish in advanced stages of maturity (IV and above) were observed almost throughout the six months period. Spent fish were, however, observed only in May and June.

Percentage of empty stomachs was high in May and June; the fish was observed to feed mainly on copepods and to some extent on other crustaceans, bivalves and gastropods; phytoplankton elements were negligible in the diet. In the case of *S. bataviensis*, data were available only for January. Fishes of advanced stages of maturity contributed to the catch. The studies of food revealed that this species consumed gastropods and bivalves in greater proportion than did *S. heterolobus*.

5. Nemipterus japonicus fisheries:

At Madras: The estimated landings of this species during the different months were as follows: January 1405 kg at Royapuram by pablo boat, February-4500 kg by deep sea vessels, March-10500 kg by deep sea vessels, April-2680 kg by deep sea vessels, May and June-nil, July-nil, August-13600 kg, September-no data, October-600 kg, November-1200 kg and December 2000 kg. The total length of the fish in the *first half year* varied from 81 to 330mm; the dominant size-groups were 131-140 mm, 141-150 mm, 201-210 mm, and 231-240 mm. Except for a few immature fish, all the others were either ripe or partly spawned or spent and recovering phase. There was a preponderence of females in the catch; the food was mainly comprised of crabs, prawns, *Sepia* sp, *Octopus*, fish remains and copepods.

In the second half of the year: The size-ranges were as follows:

Month	*Size-range*(mm)	*Mode* (mm)
July	no data	
August	81-180	111-120
September	no landings	
October	141-190	161-170
November	141-270	191-200
December	151-280	161-170

Except for a few immature fish during the month of August, all the other specimens examined in the second half of the year were ripe or partly spent or in the spent-recovering phase. There was a dominance of females in the catch. The food was mainly comprised of remains of crabs, prawns, fish, *Sepia, Octopus* and copepods.

6. Malabar sole fisheries:

A. Cynoglossus semifasciatus:

The following were the estimated landings of the malabar sole, *Cynoglossus semifasciatus* at Calicut (Velleyil) and Mangalore during different months of the year:

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Months	Calicut	Mangalore
January	71.47 metric tons	177.48 metric tons
February	148.53 ,,	98.16 ,,
March	175.58 ,,	184.04 ,,
April	99.29 ,,	54.22 ,,
May	24.13 ,,	22.55 ,,
June	0.05 ,,	0 ,,
July	0 ,,	0 ,,
August	0 ,,	0 ,,
September	50.22 ,,	0 ,,
	(+ 1.12 by carrier boats)	
October	10.53 metric tons	5.83 ,,
	(+ 15.20 by carrier boats)	
November	0.51 metric tons	17.64 ,,
	(+ 16.42 by carrier boats)	
December	52.75 metric tons	5.85 ,,
Total	665.79 metric tons (incl. 32.74 metric tons by carrier boats)	565.77 metric tons

The *Cynoglossus* fishery at Calicut (Valleyil) was fairly good in the first half-year but rather poor in the second half year. Of *C. dubius* the best monthly catch of 8.03 metric tons was obtained in February. During January, March and April the estimated landings of *C. dubius* at Velleyil were 2.74, 7.05 and 0.97 metric tons respectively; there were no catches of this fish in the remaining months upto the beginning of the last quarter. Poor catches of 40 kg and 9 kg were recorded in October and November while in December the catch of *C. dubius* was 1.92 metric tons. The annual total estimated catch of this fish at Velleyil was 20.76 metric tons.

The fishery of the malabar sole at Mangalore also showed a trend similar to that at Calicut, for the catches were good in the first half of the year and rather poor in the second half-year. The month of the best catches was March at both the places. There was only a small difference in the actual catch figures for this month at the two places (175.58 metric tons at Calicut and 184.04 metric tons at Mangalore). Ullal showed very poor sole landings, while Baikampady was slightly better with a total of 3.83 metric tons (in the second half-year only); only the indigenous gears were used at these two centres.

The catches of the first half of the year at Calicut were made by the *Paithuvala* and also by the mechanised boats. There were no landings in July and August; in September the local sole fishing was done by *Nethelvala* in which *C. semifesciatus* formed 41.57% of the total fish catch. The mechanised boats were not used in September but these were mainly used in the later part of the year. At Mangalore the main sole landings of the year were by mechanised boats only.

Length frequencies: The total length range and modal positions in the Mangalore samples during the different months of the year were as follows:

Month	*Range* (mm)	*Mode* (mm)
January	90-169	140-144 & 130-134
February	75-179	140-149
March	105-169	135-144
April	85-164	85-94
May	85-169	90-94 & 140-144
June to August	nil	nil
September	105-169	115-129
October	nil	nil
November	115-144	130-139
December	nil	nil

At Calicut the length frequency distribution during the different months of the first half year was as follows (both commercial and departmental samples were treated together):

Month	*Range* (mm)	*Mode* (mm)
January	4-4.9 to 15-15.9	5-6.9, 9-10.9 & 14-14.9
February	4-4.9 to 16-16.9 (& one 17-17.9)	5-5.9, 9-10.9 & 14-14.9
March	3-3.9 to 16-16.9	4-5.9 & 7-10.9
April	3-3.9 to 12-12.9	4-9.9
May	3-3.9 to 13-13.9	5-5.9 & 8-9.9
June	—	—

The most common modal group during the July-September quarter at this centre was in the 11-11.9 cm group; this was also the only mode noticed in all the outside samples examined in September. A small sample from Pudiappa on 13-9-69 had a higher frequency in the 9-9.9 cm group than in the other size-groups. In a Velleyil sample of 7th July there was only one mode at the 14-14.9 cm group, the size-ranges being 10-10.9 cm and 16-16.9 cm. The absolute size-range noticed for the entire quarter (July-September) was from the 6-6.9 cm to 16-16.9 cm groups; the smallest sizes between 6 cm and 9 cm were very few.

In October, the commercial samples from Velleyil showed a mode at 11-11.9 cm, the size range of the sample being 9-9.9 cm and 14-14.9 cm; the departmental samples for the same month was only 36 specimens in the six-fathom region, the latter measuring 7.9 cm and 11.9 cm. During November the Velleyil samples ranged from 10-10.9 cm to 14-14.9 cm

range, and the mode was found at 11–11.9 cm on one occasion and at 12–12.9 cm. on another occasion. The departmental samples of November were better than those of October, the total numbers available for the month were 114 fishes from 6-fathom region and only 6 from 3-fathom region. The latter ranged from the 11 to 12.9 cm group with one specimen in the 4-4.9 cm range. The 6 fathom specimens ranged from the 8-8.9 cm and 14–14.9 cm, with a mode between 11 cm and 12.9 cm (mainly in the 11–11.9 cm group). December showed slightly better departmental catches than those of the previous months, with a total of 141 *C. semifasciatus* from the 6-fathom station and 45 from the 3-fathom station; the latter samples consisted only of juveniles with size ranges 2–2.9 cm and 8–8.9 cm having a mode at 6–6.9 cm. The 6-fathom samples, on the other hand, showed both juveniles and adults of the previous broods there being a clear size-gap between the two broods; juveniles ranged from the 4-4.9 cm to 8–8.9 cm groups while the others ranged from the 11–11.9 cm to 14–14.9 cm group; the mode was at 6-6.9 cm for the juveniles and at 13-13.9 cm for the adults. Velleyil sample in December ranged from 11-11.9 cm to 14–14.9 cm groups with modes at 12-12.9 cm and 13-13.9 cm groups. A total of 99 specimens obtained from Quilandy during the month showed the same general size-range as at Velleyil, the mode being in the 12–12.9 cm group.

An important difference between Mangalore and Calicut with regard to size-distribution during the year was the absence of small juveniles at the former centre, the smallest size reported from there was in the 75—79 cm group (in February), while sizes as small as 2—2.9 cm group were caught by the departmental boat at Calicut.

Sex-ratio and Maturity: At Mangalore almost all stages of maturity were observed during January to March, while stages I, II and III were only available in April and May. However, fish in stages I and II were dominant in January, April and May, while stage II was dominant in February and March. The percentage of males in the monthly samples examined varied between 41.05 and 64.0 during the year while the monthly percentage of females ranged from 36.0 to 51.6. Almost all the stages of maturity were again represented at Mangalore during the second quarter; stages IV and VI dominated in October, V and VI in November, and II and VI in December.

At Calicut gonad examination revealed that during the first quarter the bulk of catches (those in modal group 10—10.9 cm and below) were in stage I of maturity only. There appeared some delay than usual, in the appearance of the higher stages of maturity; recruitment of juveniles continued throughout the half-year (January—June) with varying degrees of intensity; stages II and III were noticed in females during April and May. The sex-ratio in the monthly samples examined showed 88 males and 99 females in April, 95 males and 95 females in May. In the second half-year

however, the males were more numerous than the females. There were 465 males to 408 females. The juveniles of the last quarter were in the early stage of maturity, while the older fishes had gonads in stages above IV including the spent stage.

Food Studies : The gut contents during the first half-year at Mangalore included polychaetes and copepods; diatoms namely, *Fragilaria oceanica, Coscinodiscus* sp., *Pleurosigma* sp. and *Thalassiothrix* sp. In the second half-year the gut contents included polychaete remains, fish remains and diatoms such as *Fragilaria oceanica, Pleurosigma* sp. and *Coscinodiscus* sp.

B. Cynoglossus dubius:

At Calicut: The size-range observed in the available samples of this species in the month of January was 14—14.9 cm to 25—25.9 cm (55 Nos.), in February 17—17.9 cm to 27—27.9 cm (56 Nos.) and in March, 25.4—31.4 cm (7 Nos.). Females of this species at 27 cm length were at maturity stage I in March. In April *C. dubius* measuring 32.4 cm and 35.5 cm were seen to be at the maturity stage II (females). Fifteen specimens of *C. dubius* were available for examination in the July-September quarter and 43 individuals in the last quarter of the year. All the individuals of the former sample were obtained in a single day (13-8-1969). Their total length ranged from 14—14.9 cm to32—32.9 cm, with a sex-ratio of 11 males to four females; one of the females measuring 32.6 cm in total length was in maturity stage V. Specmens of *C. dubius* in the last quarter of the year mainly ranged from 26.0 cm to 35.6 cm in the commercial samples; but 8 juveniles ranging from 4.3 cm to 11.2 cm were caught by the departmental boat on 12th December. All large females in this quarter had their ovaries in stage IV - V.

Other species: Other species of *Cynoglossus* occurring occasionally in the catches were also examined.

7. Selar kalla fisheries:

At Madapam: The total landings of *Selar kalla* were: 372 kg in August, 982 kg in September, 308 kg in October, 1222 kg in November and only 33 kg in December. The size—composition ranged from 13—167 mm in August and 24—174 mm in September. In August the fishery was supported by adult fishes while in September by small specimens. During October the sizes ranged from 15—155 mm, in November from 35—165 mm and in December from 30-160 mm. In October the fishery was supported by medium-sized specimens, in November by medium and adult specimens and in December by small and medium specimens. The sex-ratio in August was females 55% and males 45% and in September 50% each. In {October males were 66% and females 34%; in Novemebr 52% were males and 48% females and in December, males were 49% and females 51%. The maturity conditions ranged from I to VI; during August and September stages II and

however, the males were more numerous than the females. There were 465 males to 408 females. The juveniles of the last quarter were in the early stage of maturity, while the older fishes had gonads in stages above IV including the spent stage.

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III were dominant; during October, November and December, stages I, III and IV were dominant respectively. The food items consisted of fishes and crustaceans. These investigations relate to the half-year ending December 1969.

8. Lactarius lactarius fisheries:

At Madras: This fishery started in the middle of August and continued till the end of December. Samples were taken from landings of offshore fishing vessels. The length varied from 80—204 mm. In the first quarter, most of the fishes examined were in maturing condition. Large number of juveniles were encountered in the second quarter. Anchovies were the major food item and a few elvers were also found in the stomach contents. At Nagapatinam large fishes measuring upto 250 mm were caught by gill net during September.

DEMERSAL FISHERIES

Veraval: Biological studies on *Otolithus ruber* and *Johnius dussumieri* have been continued.

Bombay: During 1969, four of the Government of India vessels viz., M. T. Kalyani IV, M. T. Kaylani V, M.V. Sagarkumari and M. F. V. Meenakhojini (newly acquired vessel), by otter-trawling on the continental shelf between 15° N and 22° N in Bombay - Saurashtra waters, landed 399,434 Kg fish for a fishing effort of 1884.39 hours at an overall catch rate of 211.97 kg/hr. 'Sagarkumari' fished only during the period, March to May; M. T. Kalyani IV did not operate in January and February in the first quarter and in all the months of the 3rd quarter; M. T. Kalyani V fished in all the four quarters of the year; Meenakhojini carried out fishing operations only on 4 days in the fourth quarters. In the year 1968 the Government of India vessels (Kalyanis IV and V) from Bombay base fished 336,004 Kg of fish at a catch rate of 425 Kg/hr for a fishing effort of 789.99 hrs.

During the year under report, rhe performance of these vessels in the first half-year (January to June) was excellent with a catch of 336,857 Kg of fish at a catch rate of 225.45 Kg/hr as against a low catch of 62,577 Kg of fish at 160.35 Kg/hr in the second half of the year. The catch data are shown in Tables I to V.

One remarkable feature in the trawling operation of the Government of India vessels during the year 1969 is that the quality fishes such as 'Ghol' *(Pseudosciaena diacanthus)*, 'Koth' *(Otolithoides brunneus)*, 'Dara' *(Polydactylus indicus)* and 'Karkara' *(Pomadasy hasta)* have shown an immense increase in catch abundance, catch per hour returns, and percentage composition in the total catches as compared to those in the previous year (Table V). The increase of 'Dara' from about half a ton in the earlier year to nearly 25 tonnes in 1969 is apparently a distinct indication of a prospective revival of this fishery which has declined considerably in the past

however, the males were more numerous than the females. There were 465 males to 408 females. The juveniles of the last quarter were in the early stage of maturity, while the older fishes had gonads in stages above IV including the spent stage.

Food Studies : The gut contents during the first half-year at Mangalore included polychaetes and copepods; diatoms namely, *Fragilaria oceanica, Coscinodiscus* sp., *Pleurosigma* sp. and *Thalassiothrix* sp. In the second half-year the gut contents included polychaete remains, fish remains and diatoms such as *Fragilaria oceanica, Pleurosigma* sp. and *Coscinodiscus* sp.

B. Cynoglossus dubius:

At Calicut: The size-range observed in the available samples of this species in the month of January was 14—14.9 cm to 25—25.9 cm (55 Nos.), in February 17—17.9 cm to 27—27.9 cm (56 Nos.) and in March, 25.4—31.4 cm (7 Nos.). Females of this species at 27 cm length were at maturity stage I in March. In April *C. dubius* measuring 32.4 cm and 35.5 cm were seen to be at the maturity stage II (females). Fifteen specimens of *C. dubius* were available for examination in the July-September quarter and 43 individuals in the last quarter of the year. All the individuals of the former sample were obtained in a single day (13-8-1969). Their total length ranged from 14—14.9 cm to32—32.9 cm, with a sex-ratio of 11 males to four females; one of the females measuring 32.6 cm in total length was in maturity stage V. Specmens of *C. dubius* in the last quarter of the year mainly ranged from 26.0 cm to 35.6 cm in the commercial samples; but 8 juveniles ranging from 4.3 cm to 11.2 cm were caught by the departmental boat on 12th December. All large females in this quarter had their ovaries in stage IV - V.

Other species: Other species of *Cynoglossus* occurring occasionally in the catches were also examined.

7. Selar kalla fisheries:

At Madapam: The total landings of *Selar kalla* were: 372 kg in August, 982 kg in September, 308 kg in October, 1222 kg in November and only 33 kg in December. The size—composition ranged from 13—167 mm in August and 24—174 mm in September. In August the fishery was supported by adult fishes while in September by small specimens. During October the sizes ranged from 15—155 mm, in November from 35—165 mm and in December from 30-160 mm. In October the fishery was supported by medium-sized specimens, in November by medium and adult specimens and in December by small and medium specimens. The sex-ratio in August was females 55% and males 45% and in September 50% each. In {October males were 66% and females 34%; in Novemebr 52% were males and 48% females and in December, males were 49% and females 51%. The maturity conditions ranged from I to VI; during August and September stages II and

III were dominant; during October, November and December, stages I, III and IV were dominant respectively. The food items consisted of fishes and crustaceans. These investigations relate to the half-year ending December 1969.

8. Lactarius lactarius fisheries:

At Madras: This fishery started in the middle of August and continued till the end of December. Samples were taken from landings of offshore fishing vessels. The length varied from 80—204 mm. In the first quarter, most of the fishes examined were in maturing condition. Large number of juveniles were encountered in the second quarter. Anchovies were the major food item and a few elvers were also found in the stomach contents. At Nagapatinam large fishes measuring upto 250 mm were caught by gill net during September.

DEMERSAL FISHERIES

Veraval: Biological studies on *Otolithus ruber* and *Johnius dussumieri* have been continued.

Bombay: During 1969, four of the Government of India vessels viz., M. T. Kalyani IV, M. T. Kaylani V, M.V. Sagarkumari and M. F. V. Meenakhojini (newly acquired vessel), by otter-trawling on the continental shelf between 15° N and 22° N in Bombay - Saurashtra waters, landed 399,434 Kg fish for a fishing effort of 1884.39 hours at an overall catch rate of 211.97 kg/hr. 'Sagarkumari' fished only during the period, March to May; M. T. Kalyani IV did not operate in January and February in the first quarter and in all the months of the 3rd quarter; M. T. Kalyani V fished in all the four quarters of the year; Meenakhojini carried out fishing operations only on 4 days in the fourth quarters. In the year 1968 the Government of India vessels (Kalyanis IV and V) from Bombay base fished 336,004 Kg of fish at a catch rate of 425 Kg/hr for a fishing effort of 789.99 hrs.

During the year under report, rhe performance of these vessels in the first half-year (January to June) was excellent with a catch of 336,857 Kg of fish at a catch rate of 225.45 Kg/hr as against a low catch of 62,577 Kg of fish at 160.35 Kg/hr in the second half of the year. The catch data are shown in Tables I to V.

One remarkable feature in the trawling operation of the Government of India vessels during the year 1969 is that the quality fishes such as 'Ghol' *(Pseudosciaena diacanthus)*, 'Koth' *(Otolithoides brunneus)*, 'Dara' *(Polydactylus indicus)* and 'Karkara' *(Pomadasy hasta)* have shown an immense increase in catch abundance, catch per hour returns, and percentage composition in the total catches as compared to those in the previous year (Table V). The increase of 'Dara' from about half a ton in the earlier year to nearly 25 tonnes in 1969 is apparently a distinct indication of a prospective revival of this fishery which has declined considerably in the past

ten years, causing much concern to the fishing industry. Wam *(Muraenesox talabanoides)* which finds a high demand in Bombay has increased from about 3 tonnes in the previous year to over 72 tonnes in 1969. There has been a slight decrease in the prawn catches by these vessels. The poor quality fish, viz 'Dhoma' has decreased considerably forming only about 14% in 1969 as compared to a high percentage of about 45 in 1968. It may be mentioned that during the earlier part of the year 1969, when there was monetary incentive offered to the crew there has been an intensive exploitation of the northern regions which are well known for the preponderance of quality fishes.

A few trial operations of purse-seining carried out in November and December by M. V. Meenakhojini have yielded very fruitful results. A catch of 15,745 Kg of fish for a fishing effort of 3.42 hr. at a catch rate of 4,603.80 Kg/hr was obtained, comprising mostly of mackerel and oil sardine (Table III).

The bull trawlers of the New India Fisheries Ltd., operating from Bombay have landed 1,374,685 Kg fish at a catch rate of 1081.44Kg/hr. The fishing effort expended was 1271.16 hrs for 1128 hauls. The particulars of the catch composition are shown in table VI. It may be noted that these vessels have registered a substantial increase in the 'Dara' yield from about 7 tonnes in 1968 to over 30 tonnes in 1969.

The smaller vessels of this Company have expended a major part of their fishing effort viz., 5877.49 hrs in shrimp trawling at depth range 11—62 m, and made 4775 hauls. The total catch landed was 771,574 Kg at a catch rate of 131.28 Kg/hr. The prawn catch was 517,284 Kg obtained at 88.01 Kg/hr, forming 67.04%. It is worth noting that shrimp trawling from Bombay by the New India Fisheries vessles has proved a commercial success in the past three years. During 1969 (519 tonnes) shrimp landings by all these vessels were twice as much as in 1967 (237 tonnes) and about the same as in 1968 (568 tonnes).

Studies on catch trends and fishery biology of Polynemid species, *Pseudosciaena diacanthus*, *Otolithoides brunneus*, *Pomadasys hasta*, *Muraenesox talabonoides* and *Lactarius lactarius* from the trawler landings have been continued. Studies on cat-fishes and miscellaneous groups obtained from the trawler catches have been started. Data on landings and biology of the Bombay Duck, *Harpodon nehereus* have been collected.

Karwar : There was an unprecedented activity in trawl fishing by the mechanised boats from this base in the year 1969. 179 boats with engines from 10 HP to 110 HP operated for six months, January to May and in December. In all 9604 hauls were made and a total catch of 1,425,432 Kg was obtained with catch rates varying from 56.04 to 320.00 Kg/haul by different boats. The period from January to March was the best, when the returns were very high. Four large areas were covered viz. 14-73/5F, 6F, 14—74/5A and 6A. Of these 14—74/5A was found to be the richest.

Prawns formed an important item in the trawl catches. They amounted to 327,768 Kg forming 22.99 % of the total catch. The major portion of the prawn catch was fished by the 30 H. P and 36/37 H. P. boats. For prawns, 14—74/5A1, 5A2, 5A3 and 6A1 proved to be very rich grounds. The period, December to February was considered to be the best season for prawn fishery in this region.

Silver bellies, *Opisthopterus tardoore*, sciaenids and *Lactarius* became secondary in importance due to very good landings of prawns.

Mangalore: The mechanised boats of the Training Centre of the Directorate of Fisheries, Mysore State, and those of the ex-trainees stationed at Mangalore base, fished by trawling in waters around Mangalore, Mulki, Malpe and Ganguli and landed a total catch of 7,126,058 Kg of all fish at the rate of 220.56 Kg per operation. Prawns which were 1,831,373 Kg formed 20.73 % of the total catch. The catches per operation of prawns and fish amounted to 56.88 Kg and 163.88 Kg respectively. As may be seen from table IX the total catches as well as the prawns and fishes were higher than in the previous year. The catch of prawn per operation was also higher in the current year than in the previous year.

In addition to trawling, the Training Centre boats carried out gill-netting (8 sets) at Mangalore centre during October to December and landed a catch of 475 Kg of all fish at 59.37 Kg per operation.

Cochin: The catch data of the Government of India vessels, the Indo-Norwegian Project vessels and the Cochin Company's vessels operating from the base have been furnished in the following account.

Government of India vessles: In the first half year fishing was extremely poor; M. V. Pratap fished for 21 hours for a meagre catch of 1,522 Kg of fish. In the second half year M. V. Pratap and M. V. Flying Fish were operating for 584.6 hours resulting in a catch of 81,853.5 Kg. of all fish at 140.00 Kg/hr. The total actch for the year amounted to 83,375.5 Kg at 137.65 Kg/hr., with a meagre prawn catch of 2.33%. In 1968 a total of all fish amounting to 63,985.5 Kg was obtained at 69.17 Kg/hr. with the prawns forming 8.59% of the catch. Altogether 22 subareas under the major areas 8—76, 9—76, 10—75 and 10—76 were fished. The area-wise and depth-wise distribution of the fish and prawn catches have been studied in detail.

Indo-Norwegian Project's medium vessels (24—90 H. P.) Trawling: About 226 tonnes were landed in 1969 at the rate of 51.45 Kg/hr. The fish component was about 147 tonnes and the prawn component 119 tonnes, at the rate of 28.40 Kg/hr (55.21%) and 23.05 Kg/hr (44.78%) respectively. In the year 1968 over 248 tonnes were landed by these vessels, with fish and prawn components being 140 tonnes (56.54%) and 108 tonnes (43.46%) respectively.

Indo-Norwegian Project's purse seining operations: In the first half year, viz. in January and February purse-seining operations were carried out for a catch of 26,677 Kg, the major portion of the catch being comprised of miscellaneous fishes along with oil sardines, *Anchoviella* etc. In the second half-year, purse.seining operations were resumed during October—December and for 125.5 hrs of fishing off Cochin, a catch of 87,036 Kg of fish, mainly oil sardine and mackerel was obtained, the overall catch rate being 693.51 Kg/hr. The catch per hour returns of oil sardine and mackerel were 618.72 Kg/hr and 50.97 Kg/hr. respectively.

Indo-Norwegian Project's pair trawling operations: Pair trawling was also conducted by the vessels during July and August for 39 hrs at 6-15 meter depths off Cochin. The overall catch was 80.84 Kg/hr. The prawn catch was negligibile.

Hand-line operations by INP vessels: In the first half of the year, for a total of 217 hrs of fishing effort in grounds from Trivandrum to Cannanore, 19,080 Kg of fish, mostly *Epinephelus* sp. was caught. In the second half of the year hand-lining operations were carried out in all the months except from August to September. For 109.16 hrs of fishing there was a catch of 5316 Kg of fish, mostly *Epinephelus* sp. The grounds were at 77 to 124 m depth, from south of Alleppey to Chettuvayi.

INP Larger vessels (120-480HP) - Trawling: A total of 249,704.5 Kg of fish, prawns, lobsters and crabs was obtained during the year at the rate 316.56 Kg per hour, as against a total yield of 157,784.5 Kg at the rate of 235.46 Kg. per hour during 1968. Particulars of catches group-wise and sub-period-wise are shown in table XII.

In the first half of the year over 57 tonnes of deep sea lobster *Puerulus sewelli* were landed from grounds off Quilon. The grounds were 8-75/5E, 5F, 6F; 8-76/5A, 6A; 9-75/IF and their depths ranged from 110 to 293 m. Berried females in great abundance were found in comparatively shallower areas during February and April and subsequently they were trawled from deeper waters (183—293 meters). The availability of a large number of berried females in shallower grounds seems to indicate a breeding migration to these grounds.

In the second half of the year when the exploratory fishing vessels were covering the continental slope, between Tellicherry and Quilon the deep sea lobsters were again found at depths from 200 to 366 m. The catch rates were significantly high (50 to 440 Kg/hr.) off Badagara, Beypore and between Kayankulam and Quilon at depths 201—274 m.

The deep sea crab *Charybdis edwardsi* were caught in substantial quantities from January-March and November-December from the continental slope area particularly off Kayankulam and Quilon with catch rates ranging from 600 to 2000 Kg/hr.

The species of fishes caught from the lobster grounds were mainly *Parascolopsis, Emmelichthys, Myripristis, Lethrinus* and *Priacanthus.*

Mid-shelf grounds (24-64 m) between Quilon and Cochin have been found to be quite productive for *Nemipterus*, particularly during July-September.

Elasmobranchs, mostly rays, at 29-62 metres along the Wadge Bank and also along the shelf region between Quilon and Cochin, were in abundance. The best catch rates of 846 to 1154 Kg/hr of trawling for elasmobranchs came from 40-47 meter depths, north-west of Quilon.

Parapandalus sp., *Penaeopsis* sp., *Heterocarpus* sp., *Metapenaeopsis* sp., etc. were the common prawns from deep waters. The prawn grounds were at 247 to 357 metres depth off the Kayankulam-Quilon slope and also off Tellicherry. The yield from these grounds was generally between 75 to 591 Kg/hr.

Operations of the Cochin Company's vessels: These vessles were fishing off Cochin and also off Alleppy. In 1969 fishing in Cochin region, gave a catch of 51,121.25 Kg at the rate of 35.87 Kg/hr. The fish and the prawn components were almost equal, being 26,426.75 Kg and 24,694.50 Kg respectively. Further details are given in Table XIII.

These vessels while fishing in the Alleppey region obtained a catch of 8760 Kg at the rate of 138.09 Kg/hr. The fish and prawn components were 5205 Kg and 3555 Kg respectively (Table XIV).

Vizhinjam: A study of the catches of the mechanised boats at Neendakara was intitiated in September 1969. Observations were conducted two days per week. On each day of observation, the catches of 10-20% from the operated boats were estimated. From these data estimates were made of the total landings per day and also for each month.

The mechanised boats were mostly of the Pablo type and were engaged in daily fishing. Two types of nets were employed by these boats i.e. the Otter trawls and drift nets. The former were operated by boats having 16—75 HP engines and the latter by boats with 8—16 HP engines. The area of operation was around Neendakara.

Landing by Otter trawls: The number of units operated during September—December was 19347 and the total catch was 3208 tonnes, the average catch per unit per day (catch per boat per trip) was about 166 Kg. The average catch per unit was the highest in September (326 Kg) and declined steadily to 57 Kg in December. Catch trends of important categories are given below:

Categories		% of catch (Sept.—Dec.)	Month of highest catch per unit per day
Elasmobranchs	...	1.3	December (8.0 Kg)
Cat fishes	...	3.9	October (14.0 Kg)
Nemipterus	...	30.1	September (175.0 Kg)
Saurida	...	23.4	September (118.0 Kg)
Upeneus spp.	...	3.8	October (15.0 Kg)
Caranx spp.	...	1.4	October (4.0 Kg)
Sciaenids	...	5.9	October (19.0 Kg)
Prawns	...	7.1	September (12.7 Kg) and November (12.1 Kg)

Landings by drift nets: The number of units operated were 4811. The total catch was 416 tonnes and the catch per unit was about 87 Kg. The highest monthly catch was in November (110 Kg) and the lowest in December (54 Kg). Catch trends are given below:

Categories of fishes	% in total catch (Sept. —Dec.)	Month of highest catch per unit per day
Elasmobranchs	37	October (39 Kg)
Scomberomorus spp.	30	November (41 Kg)
Cat fishes	15	November (24 Kg)

Tuticorin: The Government of India fishing vessels of the Offshore Fishing Station, Tuticorin viz., M.F.V. Meenabharathi and M. F. V. Jheenga had been shifted to Madras for operations in that region. They started fishing from February 1969. M.F.V.Meenabharathi had landed about 96 tonnes of fish at the rate of 260.79 Kg/hr and put in a total fishing effort of 367.54 hrs and M.F.V. Jheenga had obtained a catch of nearly 70 tonnes at 158.83 Kg/hr for a total effort of 438.05 hrs. The prawn landings formed a negligible proportion (0.25 %). Areawise catches are not known (Table XV).

Visakhapatnam: Two vesseles M. T. Ashok and M. V. Champa of the Offshore Fishing Station, Visakhapatnam operated during the year, as in the previous year. They fished only in one major area viz., 17–83, the subareas thereof being 4A, 4B, 4C, 5C, 5D, 6C and 6D. Together, these vessels obtained a catch of 114,543.5 Kg of fish at 123.21 Kg/hr for a total fishing effort of 929.68 hrs. In 1968, the total catch was 124,255 Kg of fish for 1036.30 hrs of fishing effort at the rate of 119.90 Kg/hr. Although the total catch was a little less, as also the effort expended, the over all catch rate was higher in 1969 than in 1968. In 1969 for M. T. Ashok, the fishing effort expended was 331.68 hrs for a catch of 47,695.5 Kg of fish at 143.80 as against 387.18 hrs expended for a catch

of 59,006.5 Kg of fish at the rate of 152.4 Kg/hr in 1968. Both the catch and the catch rate were less in 1969 for this vessel. For M. V. Champa the fishing effort was 598.0 hrs for a catch of 66,848 Kg of fish at the rate of 111.78 Kg/hr as against 649.12 hrs for a catch of 65249 Kg of fish at 100.5 Kg/hr in 1968. It may be noted that both the catch and the catch rate were higher than in 1968 (Table XVI and XVII).

Miscellaneous fishes and catfishes comprised the bulk of catches of these vessels. Ranking next were the elasmobranchs. Prawns formed about 4% of the total catch. The quality fishes viz., the miscellaneous big fishes were represented to a lesser extent than in the previous year.

Four commercial trawlers (60 HP) of the Andhra Fishermen's Co-operative Society at Visakhapatnam together yielded in the first half of the year 60,705.15 Kg of fish at 277.2 Kg per day of fishing and in the second half of the year 26,180.9 Kg of fish at 148.8 Kg per day of fishing. The number of fishing days, the total landings and also the yield per day of fishing were higher in the first half of the year than in the later half. The miscellaneous small fishes formed the bulk (68.05%). The prawn yields were very much higher than those of the Government of India vessels. These vessels during the year obtained 16,626.05 Kg of prawns forming 19.14% of the total landings (Table XIX).

Biological studies on catfishes *(Tachysurus thalassinus* and *T. tenuispinis)* sciaenids *(Pseudosciaena aneus* and *Johnius carutta), Pomadasys hasta,* silver bellies *(Leiognathus bindus) Nemipterus japonicus* and *Carangoides malabaricus* have been continued.

DETAILS OF LANDINGS BY OEFSHORE FISHING VESSELS

TABLE I.

Catch data (Kg) of the Government of India vessels of Bambay base for 1969. trawling operations. The figures in paremthesis refer to natch rate as (Kg/hr)

Period Quarter	M. T. Kalyani IV	M. T. Kalyani V	M. V. Sagar-kumari	M. V. Meena-khojini	Total
1st Half yr. (Jan-June)	110,852 (235.44)	222,944 (258.29)	3,061 (19.11)	—	336,857 (225.45)
3rd quarter (July-Sept)	—	1,558 (58.79)	—	—	1,558 (58.79)
4th quarter (Oct-Dec)	41,549 (185.69)	17,577 (141.18)	—	1,893 (122.05)	61,019 (167.74)

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Total for 1969					
Catch Kg.	152,401	242,079	3,061	1,893	399,434
Effort Hrs.	694.57	1014.15	160.16	15.51	1884.39
Catch per hr(Kg)	219.42	238.70	19.11	122.05	211.97
Total for 1968					
Catch Kg	174,900	161,104	—	—	336,004
effort Hrs	412.33	377.66	—	—	789.99
catch per hr(Kg)	424.17	426.58	—	—	425.33

TABLE II

Areas fished by trawling operations by the Government of India vessels of Bombay base in 1969

Name of vessel (H. P.)	Quarter & Months	Areas fished
M. T. Kalyani IV (300 HP)	1st Quarter (March only)	19-71/2F, 33F, 4C, 4D, 4E, 5B, 5C, 6A, 19-72/2A; 20-70/2F; 20-71/1A, 1B, 2B; 22-68/1F, 2C, 2D, 2E, 3C, 3D.
,,	2nd Quarter (April, May and June)	18-72/1E, 2D, 6C, 6D; 19-71/2F, 3D, 3E, 3F, 4D, 5A, 5B, 5C; 19-72/1C, 2B, 3A; 20-69/5F, 6F; 20-70/5A; 21-69/1F, 2D, 2E, 3D; 22-67/2E, 5E, 6D, 6E; 22-68/2C, 2D, 2E, 3C, 6A.
,,	3rd Quarter (July to Sept.)	No fishing.
,,	4th Quarter (Oct, Nov. Dec.)	18-72/1B, 1C, 2D, 3C, 5E, 6B, 6C, 6D, 6E; 19-71/1E, 2F, 3E, 3F, 4D, 4E, 4F, 5A, 5B: 19-72/1B, 2A, 2E, 3A; 20-70/3C 3E, 4B; 20-71-1A, 1B, 2A, 2B.
M. T. Kalyani V (300 HP)	1st Quarter (January, February & March)	17-72/6E; 18-72/1E, 2E, 3D, 3E, 4D, 5B, 5C, 6B,6C; 19-71/2D, 2E, 2F, 3C, 3D, 3E, 4B, 4C, 4D, 4E 5A, 5B, 5C, 5D; 19-72/1A, 2A, 2B, 3D; 20-71/2A; 21-69/2D, 2E, 3C, 4B, 5B,6A; 22-68/1E, 1F, 2D, 2E, 3C, 3D, 3E.

,,	2nd Quarter (April, May and June)	18-72/5B, 5C, 5D, 6B, 6C, 6D; 19-71-2F, 3C, 3D, 3E, 3F, 4C, 4D, 4E, 4F, 5B, 5C, 5D; 19-72/1A, 1B, 1C, 2A, 3A, 3B; 20-70/4D, 4E, 5B, 5C, 6A, 6B; 21-69/1E, 1F, 2E, 2F, 3C; 21-70/1A; 22-68/1D, 1E, 2C, 2D, 2E and 2F.
,,	3rd Quarter (September only)	18-72/1B, 2E, 3D, 4B, 5D, 5E, 6D, 6E.
,,	4th Quarter (Nov. & Dec.)	15-73/6B; 16-72/5E, 5F, 6E, 6F; 16-73/1A, 3A, 5A; 17-72/1F, 2F, 5B, 5C, 6A, 6B, 6C; 17-73/1A, 2A, 3A; 18-72/1B, 1C, 2C, 5A, 5B.
M. L. Sagar-kumari (45 H.P.)	1st Quarter (March only)	18-72/4C, 4D, 5C, 5D, 6D
,,	2nd Quarter (April & May)	18-72/5D
M.F.V. Meena-khojini (200 H.P.)	4th Quarter (Oct., Nov. and December)	18-72/1E, 4E, 6D, 6E 15-73/3D, 3E, 4F, 6D 16-73/5D

TABLE III

Results of Purse-seining by M. V. Meenakhojini in 1969 (Government of India vessel from Bombay base)

	November	December	Total
No. of hauls ...	5	8	13
Depth range in meters	10-16	7-15	7-16
Fishing effort Hrs.	1.25	2-17	3-42

	Catch (c.p.h) Kg.		Catch (c.p.h) Kg.		Catch (c p.h) Kg.	
Sardines	107	(85.60)	1320	(608.29)	1427	(417.25)
Mackerel	7,497	(5,997.6)	6781	(3124.88)	14278	(4174.85)
Prawns	10	(8.00)		—	10	(2.92)
Miscellaneous fishes	30	(24.00)		—	30	(8.77)
Total	7,644	(6,115.20)	8101	(3733,18)	15745	(4603.80)

TABLE IV

Operational data for the Government of India vessels from Bombay base for 1969

	Kalyani IV	Kalyani V	Sagar-kumari	Meena-khojini (trawl)	Meena-khojini (purse seining)
No of days absent from port	78	112	35	4	13
No. of fishing days	59	91	35	4	7
Catch per day of absence from port Kg.	1953.86	2161.42	87.46	473.25	1211.15
Catch per day of fishing	2583.07	2660.21	87.46	473.25	2249.28
Catch per hour	219.42	238.70	19.11	122.05	4603.80
Catch per horse power hour Kg.	0.73	0.79	0.42	0.61	23.01

TABLE V

Catch composition of the landings by the Government of India vessels, Bombay base for 1969

	1st Half year	3rd Quarter	4th Quarter	Total (1969)	%	Total (1968)	%
Depth range meters	11-76	15-59	11-71	11-76	—	—	—
Effort hours	1,494.13	26.50	363.76	1,884.39	—	789.99	—
Name of fish	Catch and catch per hour in Kg.						
Ghol	43,321	148	1,115	44,584	11.16	10,419	3.10
	(28.99)	(5.58)	(3.06)	(23.66)		(13.19)	
Koth	20,107	—	40	20,147	5.04	925	0.28
	(13.46)		(0.11)	(10.69)		(1.17	
Dhoma	43,701	185	13,236	57,122	14.30	150,725	44.86
	(29.25)	(6.98)	(36.39)	(30.31)		(190.79)	
Dara	24,826	—	20	24,846	6.22	570	0.17
	(16.61)		(0.05)	(13.19)		(0.72)	
Karkara	13,838	45	3,745	17,628	4.41	3,201	
	(9.26)	(1.69)	(10.29)	(9.35)		(4.05)	0.95

Wam	69,245	5	3,187	72,437	18.13	3,490	1.04
	(46.34)	(0.18)	(8.76)	(38.44)		(4.24)	
Catfish	29,677	160	10,250	40,087	10.04	39,935	11.88
	(19.86)	(6.03)	(28.18)	(21.27)		(50.50)	
Prawns	826	20	938	1,784	0.45	3,464	1.03
	(0.55)	(0.75)	(2.58)	(0.95)		(4.38)	
Rays	29,135	280	4,325	33,740	8.45	62,283	18.54
	(19.50)	(10.56)	(11.89)	(17.90)		(78.84)	
Sharks and skates	14,470	200	8,223	22,893	5.73	21,635	6.44
	(9.68)	(7.54)	22.61)	(12.15)		(27.39)	
Miscellaneous	47,711	515	15,940	64,166	16.07	39,357	11.71
fishes	(31.93)	(19.43)	(43.82)	(34.05)		(49.82)	
Total	336,857	1558	61,019	399,434	100	336,004	100
	(225.45)	(58.79)	(167.75)	(211.97)		(425.33)	

TABLE VI

Catch data of bull-trawling operations by the New India Fisheries vessels from Bombay base for the year 1969: Catch (and catch/hour) in Kg.

	1st half yr.	3rd Qtr.	4th Qtr.	Total for 1969	%	Total for 1968	%
No. of hauls	815	313	-	1128	-	-	-
Depth range meters	31.55	30.50	-	30-55	-	-	-
Fishing effort(hrs)	948.08	323.08	-	1271.16	-	-	-
Ghol	52,506	8,376	*No*	60,882	4.43	53,742	2.74
	(53.38)	(25.92)	*Opera-*	(47.89)		(7.40)	
Koth	4,245	1,743	*tions*	5,988	0.43	2,381	0.12
	(4.48)	(5.39)		(4.71)		(0.33)	
Dhoma	211,284	107.928		319,212	23.22	438,480	22.34
	(222.85)	(334.06)		(251.12)		(60.38)	
Dara	29,961	315		30,276	2.20	7,293	
	(31.60)	(0.97)		(23.82)		(1.00)	
Karkara	111,114	3,708		114,822	8.35	75,852	3.87
	(117.20)	(11.48)		(90.33)		(10.44)	
Wam	44,568	50,796		95,364	6.94	120546	6.14
	(47.01)	(157.22)		(75.02)		(16.60)	

Cat fish	72,792	37,152	109,944	8.00	83,610	4.26
	(78.78)	(115.00)	(86.49)		(11.51)	
Kati	80,676	18,288	98,964	7.20	50,688	2.58
	(85.09)	(56.68)	(77.85)		(6.98)	
Pomfrets	43,398	1,782	45,180	5.29	27,360	1.39
	(45 77)	(5.51)	(35.54)		(3.77)	
Prawns	1,260	756	2,016	0.15	568,530	28.97
	(1.33)	(2.34)	(1.59)		(78.28)	
Rays	62,125	42,634	104,759	7.62	76,822	3.91
	(65.53)	(131,96)	(82.41)		(10.58)	
Sharks and	143,580	24,918	168,498	12.26	241,381	12.30
skates	(151.44)	(77.13)	(132.55)		(33.24)	
Miscellareous	211,745	7,035	218,780	15.91	216,150	11.01
fishes	(223.34)	(21.77)	(172.11)		(29.76)	
TOTAL	1069.254	305,431	1374,685	100	1962,855	100
	(1127.81)	(945.37)	(1081.44)		(270.28)	

TABLE VII

Catch data of shrimp trawling operation of the New India Fisheries vessels from Bombay base for 1969

	1st Half year	3rd Quarter	4th Quarter	Total for 1969	%
No. of Hauls	3,404	122	1,249	4,775	
Depth range in metres	11-62	26-55	13-28	11-62	
Fishing effort in tonnes	4,072.41	163.67	1,641.41	5,877.49	
Fish	171,253	10,862	72,175	254,290	32.96
	(42.05)	(66.37)	(43.97)	(43.26)	
Prawns	278,658	16,074	222,552	517,284	67.04
	(68.42)	(98.21)	(135.58)	(88.01)	
TOTAL	449,911	26,936	294,727	771,574	100
	(110 47)	(164.58)	(179.56)	(131.28)	

TABLE VIII

Catch data of mechanised boats of Training Centre, Mangalore : Gill net operations in 1969

MONTH	No. of operations	Catch in Kg	Catch/Operation
October	2	253	126.50
November	3	68	22.66
December	3	154	51.33
	8	475	59.37

TABLE IX

Catch data of mechanised boats from Mangalore base for 1969

Boats of	Centre	Period	No. of operations	Catch (and catch/operations) in Kg		
				Prawns	Fish	Total
Training Centre	Mangalore	1st half year	51	3,464.5 (67.93)	5,375.5 (105.40)	8,840 (173.32)
,,	,,	4th quarter	50	830.5 (16.66)	7,899.5 (157.99)	8,730 (174.60)
Ex-Trainees	,,	1st half year	18,110	1402,032 (77.42)	3090,177 (170.63)	4442,209 (248.05)
,,	,,	4th quarter	3224	172,037 (53 36)	341,815 (75.00)	413,852 (128.36)
,,	Mulki	1st half year	1040	69,843 (67.16)	96,052 (92.36)	165.895 (159.52)
,,	,,	4th quarter	428	10,848 (25.34)	37,013 (86.48)	47,861 (111.82)
,,	Malpe	1st half year	2414	81,644 (33.82)	588,853 (243.93)	670,502 (277.75)
,,	,,	4th quarter	2512	29,806 (11.87)	132,673 (52.83)	162,479 (64.69)
,,	Ganguli	1st half year	3024	50,010 (16.54)	751,266 (249.53)	801,276 (265.07)
,,	,,	4th quarter	1456	10,858 (7.45)	343,556 (235.96)	354,414 (243.41)
			32309	1831,373.0	5294,685.0	7126,058
Total for 1969				(56.68) 25.70 %	(163.88) 74.30 %	(220.56) 100

N. B. No operations in the 3rd Quarter

1187,374	4539,358	5726,732
(49.76)	(190.22)	(239.98)
20.73 %	71.27 %	100

Total for 1968

TABLE X

Catch data of the Government of India vessles from Cochin base for 1969

Period	Depth range (m)	effort hours	Catch (and catch/hour) in Kg		
			Fish	Prawns	Total
1st Half year	–	21.00	1,522	–	1,522
			(72.47)		(72.47)
3rd Quarter	5-73	234.10	18,179	928	19,107
			(77.65)	(3.11)	(81.62)
4th Quarter	7-51	350.58	61,735	1,011.5	62,746.5
			(176.09)	(2.88)	(178.98)
Total 1969	5-73	605.68	81,436	1,939.5	83,375.5
			(134.45)	(3.20)	(137.65)
%	–	–	97.67	2.33	100
Total 1968	7-42	924.98	58,488	5,497.5	63,985.5
			(63.23)	(5.94)	(69.17)
%			91.41	8.59	100

TABLE XI

Catch data of the medium fishing vessels of the Indo Norwegian Project from Cochin base for 1969

Period	Depth range (m)	effort in hours	Catch (and catch/hour) in Kg		
			Fish	Prawns	Total
1st Half year	4-35	3,794.57	56,304.50	103,973.50	160,278.00
			(24.84)	(27.40)	(42.24)
3rd Quarter	4-40	624.43	29,306.00	5,556.75	34,862.75
			(46.93)	(8.90)	(55.83)
4th Quarter	6-37	751.42	61,256.00	9,632.50	70,888.50
			(81.52)	(12.82)	(94.34)
Total for 1969	4-40	5,170.42	146,866.50	119,162.75	266,029.25
			(28.40)	(23.05)	(51.45)
%			55.21	44.78	100
Total for 1968	3-42	4,795.81	140,162.50	108,443.50	248,606.00
			(29.23)	(22.61)	(51.84)
%			56.54	43.46	100

TABLE XII

Catch data of the Indo-Norwegian Project's larger vessles operating from Cochin base for 1969

period	Depth range (m)	Fishing effort hrs	Catch (and catch/hr) in Kg				
			Fish	Prawns	Lobsters	Crabs	Total
1st Half yr.	18-412	400.16	41,199	7,540.5	57,375	5,230	111,344.5
			(102.96)	(18.84)	(143.38)	(13.07)	(278.25)
3rd Quarter	9-366	203.40	41,130	2,726.3	3,973.5	-	47,830
			(202.21)	(13.40)	(19.53)		(235.15)
4th Quarter	29-457	185.24	65,495.5	8,920.5	4,114	12,000	90,530
			(353.57)	(48.16)	(22.21)	(64.78)	(488.72)
Total for 1969	9-457	788.80	147,824.5	19,187.5	65,462.5	17,230	249,704.5
			(187.40)	(24.32)	(82.99)	(21.84)	(316.56)
Total for 1968	6-457	670.10	75,7.02	48,294	-	-	157,784.5
			(112.97)	(72.07)			(235.46)

TABLE XIII

Shrimp trawling off Cochin : Catch data of Cochin Company's vessels from Cochin base for 1969

Period	Depth range (m)	Fishing effort hours	Catch (and catch/hour) in Kg		
			Fish	Prawns	Total
1st Half year	4-37	761.00	11,424	13,441.5	24,865.5
			(15.01)	(17.66)	(32.67)
3rd Quarter	7-11	6.00	667	174	841
			(111.17)	(29.00)	(114.17)
4th Quarter	4-37	658.00	14,335.75	11,079	25,414.75
			(21.79)	(16.84)	(32.62)
Total for 1969	4-37	1425.00	26,426.75	24,694.5	51,121.25
			(18.54)	(17.33)	(35.87)
Total for 1968	6-40	1278.00	36,017.5	21,473.5	57,491
			(28.18)	(16.80)	(44.98)

TABLE XIV

Shrimp trawling of Alleppey region : Catch data of Cochin Company's vessels from Cochin base for 1969

Period	Depth range (m)	Fishing effort hours	Catch (and catch/hour) in Kg.		
			Fish	Prawns	Total
1st Half year	11-31	156.00	2,315	3,163.5	5,478.5
			(14.84)	(20.28)	(35.12)
3rd Quorter		No Operations			
4th Quarter	9-37	74.00	2,890	391.5	3,281.5
			(39.5)	(5.29)	(44.34)
Total for 1969	9-37	230.00	5,205	3,555	8,760
			(22.63)	(15.46)	(38.09)

TABLE XV

Catch data of the Government of India fishing vessels from Tuticorin base operated off Madras during 1969

	MFV Meenabharathi		MFV Jheenga		Both vessels		%
Period	Effort horus	Catch (cph) Kg	Effort hours	Catch (cph) Kg	Effort hours	Catch (cph) Kg	Prawns
1st Half-yr.	280.74	64,319.5	269.68	42.384	550.42	106,703.5	0.21
		(229.11)		(157.16)			
July, 69	48.50	14,852	52.42	9.909	100.92	24,761	0.08
		(306.00)		(189.00)		(245.35)	
August & Sep. 69			No fishing				
Oct.69	1.00	35	18.10	4,148	19.10	4,183	Nil
				(229.17)		(219.00)	
Nov. 69	37,30	16,646	48.35	8,780	85.65	25,426	0.27
		(446.27)		(181.59)		(296.86)	
Dec. 69	—	—	49.50	4,358.5	49.50	4,358.5	0.40
				(88.05)		(88.05)	
Annual 1969	367.54	95,852.5	438.5	69,579.5	805.59	165,432	0.25
		(260.79)		(158.83)		(205.35)	

TABLE XVI

Annual landings and catch per unit effort, Govt. of India fishing vessels from Visakhapatnam base for 1969

		1969		1968	
1.	Name of vessel	M. T. Ashok	M. V. Champa	M. T. Ashok	M. V. Champa
2.	No. of fishing days	84	145	102	166
3.	No. of hauls	155	394	192	424
4.	Depth range in metres	27-55	11-64	24-48	24-48
5.	Fishing effort hours	331.68	598.00	387.18	649.12
6.	Total catch in Kg.	47,695.5	66,848	59,006.5	65,249
7.	Catch per day of fishing in Kg.	567.80	461.02	478	393
8.	Catch per haul in Kg.	307.71	169.67	307	154
9.	Catch per hour Kg.	143.80	111.78	152.4	100.5
10.	Catch per horse power hour	0.70	0.83	0.76	0.74

TABLE XVII

Catch data of the Government of India Fishing vessels from Visakhapatnam base for 1969

Vessles and Period	Squares fished	Effort hours	Catch Kg.	c.p.h Kg.	Important categories of fishes*
M. T. Ashok					
1st half year	17-83/4B, 5C, 5D, 6D	130.41	21,532	165.1	5,3,2,1.
3rd Quarter	17-83/4A, 4B, 5C	176.52	22,916.5	129.82	5,3.
4th Quarter	17-83/4B, 5C	24.75	3,247	131.2	3,5,2.
M. V. Champa					
1st half year	17-83/4B, 4C, 5C, 6C, 6D	296.01	43,631.5	147.4	5,3,2,1.
3rd Quarter	17-83/4B, 5C, 5D	144.33	11,345.5	78.61	5,3,4.
4th Quarter	17-83/4B, 5C, 5D, 6D	157.66	11.870	75.29	5,3,4,1.
Total for both vessels 1969		929.68	114,543.5	123.21	
Total for both vessels 1968		1036.30	124,255	119.90	

* 1. Sharks and Skates; 2. Rays; 3. Cat fish; 4. Prawns; 5. Miscellaneous small fishes; 6. Miscellaneous big fishes.

TABLE XVIII

Composition of the landings, Government of India fishing vessels from Visakhapatnam base for 1969

Fish categories	Catch (and catch/hour) in Kg.					
	Ashok	Champa	Total for 1969	%	Total for 1968	%
Sharks and skates	3,525	3,715.5	7,240.5	6.32	8,660	6.67
	(10.63)	(6.21)	(7.79)		(13.34)	
Rays	4,169	3,831.5	8,000.5	6.98	8,288	6.67
	(12.57)	(6.41)	(8.61)		(12.77)	
Cat fish	9,911	16,545	26,456	23.10	37,973.5	30.55
	(29.88)	(27.67)	(28.46)		(58.50)	
Prawns	2,137	2,598	4,735	4.13	4,492	3.62
	(6.44)	(4.34)	(5.09)		(6.92)	
Miscellaneous	25,027	37,690	62,717	54.76	55,873	44.97
small fishes	(75.45)	(63.03)	(67.46)		(86.07)	
Miscellaneous	2,926.5	2,468	5,394.5	5.71	8,969	7.22
big fishes	(8 82)	(4.13)	(5.80)		(13.82)	
All fishes	47,695.5	66,848	114,543.5	100	124,255.5	100
	(143.80)	(111.78)	(123.21)		(191.42)	

Miscellaneous small fishes :- *Lacarius, Leiognathus, Trichiurus, Saurida, Nemipterus, Psenes, Drepane,* Sciaenids, Carangids and flat fishes. Miscellaneous big fishes :- *Pamadasys, Psettodes,* Pomfrets.

TABLE XIX

Catch details of the trawlers (60 HP) of the Andhra Fisheries Co-operative Society, Visakhapatnam for 1969.
(Catch figures are in Kg; figures in brackets indicate catch per day)

	1st half year	3rd Qtuarr	4th Quarter	Total for 1969	%
No. of fishing days	219	79	97	395	
Sharks and skates	484	74	270	828	0.95
	(2.2)	(0.94)	(2.78)	(2.09)	
Rays	129	50	315	494	0.57
	(0.6)	(0.63)	(3.25)	(1.25)	
Catch fishes	3,615	3,126	1,027	7,768.5	8.94
	(16.5)	(39.59)	(10.59)	(19.67)	

Prawns	9,627.15	3,281	3,717,9	16,626.05	19.14
	(44.0)	(41.53)	(38.33)	(42.09)	
Miscellaneous	46,489	5,051	7,586	59,126.5	68.05
small fishes	(212,3)	(63.94)	(78.21)	(149.69)	
Miscellaneous	360	828	8.55	2,043	2.35
big fishes	(1.6)	(10.48)	(8.81)	(.517)	
Total	60,705.15	12,410	13,770.9	86,886.05	100
	(277.2)	(157.09)	(141.97)	(219.96)	

CRUSTACEAN FISHERIES

The crustacean fishery was generally good during the year along both the coasts of India and the total catch registered an increase of over 7,500 tonnes from the 1968 figure. Consequent on the late commencement of the monsoon, the 1968–69 fishing season lasted till the middle of July, and the overall landings were also better in relation to that of the previous year. Over 60% of the year's landing of prawns was registered in the first half. The percentage of penaeid prawns in the total crustacean catches exceeded 65%. The landings from the states of Maharashtra and Kerala together accounted for more than 75% of the all India landings. Biological and fishery information regarding the landings of different categories of crustaceans were collected from different centres on both the coasts of India.

PRAWN FISHERY INVESTIGATIONS

Veraval: An estimated total catch of 537 tonnes of prawns was landed by the mechanised vessels operating at this centre. Over 75% of the catches was obtained in the second half of the year, the highest catch being recorded in December. The improvement in the catch seen during the year was mainly due to the increased number of trawlers employed during the year. Fifty to sixtyfive trawlers were working at this centre during the period. Penaeid prawns, *Metapenaeus affinis* and *Parapenaeopsis stylifera* were the species contributing to the fishery. In the first half of the year, large sized *M. affinis* in the model size range of 121–125 mm to 151–155 mm dominated the catch, while in the second half, smaller prawns 111–115 mm and 116–120 mm predominated. This indicated that the fishery of the species wrs supported by the prawns belonging to 2 different age groups and that the larger group was not present in the later half of the year. The size distribution of *P. stylifera* was almost similar throughout the period, the modal size of males being 86–90 mm and that of females 106–110 mm.

The inshore prawn fishery at Navabandar was active for only four months; February–March in the first half and October–November in the second half. The total estimated catch of prawns landed by the indigenous

Prawns	9,627.15	3,281	3,717,9	16,626.05	19.14
	(44,0)	(41.53)	(38.33)	(42.09)	
Miscellaneous	46,489	5,051	7,586	59,126.5	68.05
small fishes	(212,3)	(63.94)	(78.21)	(149.69)	
Miscellaneous	360	828	8.55	2,043	2.35
big fishes	(1.6)	(10.48)	(8.81)	(.517)	
Total	60,705.15	12,410	13,770.9	86,886.05	100
	(277.2)	(157.09)	(141.97)	(219.96)	

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PRAWN FISHERY INVESTIGATIONS

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The inshore prawn fishery at Navabandar was active for only four months; February–March in the first half and October–November in the second half. The total estimated catch of prawns landed by the indigenous

Prawns	9,627.15	3,281	3,717,9	16,626.05	19.14
	(44.0)	(41.53)	(38.33)	(42.09)	
Miscellaneous	46,489	5,051	7,586	59,126.5	68.05
small fishes	(212,3)	(63.94)	(78.21)	(149.69)	
Miscellaneous	360	828	8.55	2,043	2.35
big fishes	(1.6)	(10.48)	(8.81)	(.517)	
Total	60,705.15	12,410	13,770.9	86,886.05	100
	(277.2)	(157.09)	(141.97)	(219.96)	

CRUSTACEAN FISHERIES

The crustacean fishery was generally good during the year along both the coasts of India and the total catch registered an increase of over 7,500 tonnes from the 1968 figure. Consequent on the late commencement of the monsoon, the 1968–69 fishing season lasted till the middle of July, and the overall landings were also better in relation to that of the previous year. Over 60% of the year's landing of prawns was registered in the first half. The percentage of penaeid prawns in the total crustacean catches exceeded 65%. The landings from the states of Maharashtra and Kerala together accounted for more than 75% of the all India landings. Biological and fishery information regarding the landings of different categories of crustaceans were collected from different centres on both the coasts of India.

PRAWN FISHERY INVESTIGATIONS

Veraval: An estimated total catch of 537 tonnes of prawns was landed by the mechanised vessels operating at this centre. Over 75% of the catches was obtained in the second half of the year, the highest catch being recorded in December. The improvement in the catch seen during the year was mainly due to the increased number of trawlers employed during the year. Fifty to sixtyfive trawlers were working at this centre during the period. Penaeid prawns, *Metapenaeus affinis* and *Parapenaeopsis stylifera* were the species contributing to the fishery. In the first half of the year, large sized *M. affinis* in the model size range of 121–125 mm to 151–155 mm dominated the catch, while in the second half, smaller prawns 111–115 mm and 116–120 mm predominated. This indicated that the fishery of the species wrs supported by the prawns belonging to 2 different age groups and that the larger group was not present in the later half of the year. The size distribution of *P. stylifera* was almost similar throughout the period, the modal size of males being 86–90 mm and that of females 106–110 mm.

The inshore prawn fishery at Navabandar was active for only four months; February–March in the first half and October–November in the second half. The total estimated catch of prawns landed by the indigenous

gears during the year was 69 tonnes. The catch was mainly composed of non-penaeid prawns, *Hippolysmata ensirostris*, *Palaemon tenuipes* and *P. styliferus* and the penaeid prawns, *Parapenaeopsis stylifera*, *P. sculptilis*, *M. affinis* and *Solenocera indica*. *H. ensirosiris*, dominated the catches throughout the period with modal sizes 66–70 mm in the first half and 56–65 mm in the second half. Berried females were encountered throughout the period indicating protracted breeding season for this species. *Palaemon* spp. were found in March as well as in December and their size mode varied between 46-50 mm and 56-60 mm. Among the penaeid prawns *P. stylifera* and *P. sculptilis* were caught round the year, while *S. indica* and *M. affinis* were found in appreciable quantities in the catches of March and October respectively.

Bombay: The magnitude of prawn landings at Versova and Sasoon Docks was in the order of 1642 and 1485 tonnes respectively and the catch data showed better landings at Versova during the first half of the year and at Sasoon Dock in the second half. However, in both the centres better landings were recorded in March and May and in October and November. Although about a dozen species of prawns were represented in the catches *Acetes indicus* and *Palaemon tenuipes* dominated the catch throughout the period and other prawns such as *S. indica*, *M. affinis*, *M. brevicornis*, *P. stylifera*, *P. sculptilis* and *P. hardwickii* formed supporting species in the fishery. The spcies composition and their succession in the fishery were similar to those of the previous years except in the case of *M. affinis* which was completely absent in the catches landed at Sassoon Dock during the first half of the year.

Palaemon tenuipes caught at Sassoon Dock showed 2 size groups; a smaller one at 44-46 mm and a larger one at 50–52 mm in the first half of the year, while in the second half size groups above 45 mm were predominant. Juveniles were encountered in the month of November. At Versova the modal length showed a gradual decrease from April indicating recruitment of juveniles into the fishery. In *Solenocera indica* multiple modes distributed between 51–55 mm and 61–65 mm in males and 66–70 mm and 91-95 mm in females were observed. Almost throughout the period larger specimens measuring between 106–110 mm constituted the fishery of *P. stylifera*. Juveniles of *P. hardwickii* 26–35 mm were abundant during the first 3 months of the year and as the season advanced they were replaced by larger specimens with size group 76–85 mm. In *M. affinis* the size groups above 95 mm supported the major portion of catches.

The New India Fisheries Co. Ltd., carried out shrimp trawling in the shallow waters of 13–26 m depth and landed a total catch of 558 tonnes with an over all catch-per-unit effort of 68.42 Kg/hour. The species contributing to the fishery in the order of abundance were *M. affinis* *P. merguiensis* and *M. monoceros*. Late maturing and mature females of *M. affinis* and *M. monoceros* were common in the catches.

The Government of India vessels Kalyani IV, V and Sagarkumari landed 815 and 958 Kg of prawns at a catch rate of 0.5 Kg/hr and 2.45 Kg/hr respectively in the first and second half of the year.

Karwar: The trawlers operating at this centre landed an estimated catch of 335 tonnes of prawns, of which about 75 % was obtained in the first half of the year. The poor catch obtained in the second half was mainly due to the late commencement of the season which started in December. The species composition of the catches was also different in both the halves of the year. In the order of abundance *M. dobsoni*, *M. affinis*, *P. merguienisis* and *P. stylifera* were the constituent species of the catches landed in the first half and *M. affinis* and *P. merguiensis* predominated in the second half. In the over all catch of the year, *M. affinis* ranked first and *M. dobsoni* the second. During January, March and December, large sized males of *M. dobsoni* (101-105) were common while in other months smaller size groups (71-80 mm) were predominant. Among females bigger sizes were found in the first and the last month of the year and during the rest of the period the modal sizes of the species varied between 86-90 mm and 96-100 mm. Females were dominant over the males throughout the year except in February. The males of *M. affinis* showed the principal mode at 126-130 mm in January and in subsequent months it decreased gradually to 111-115 mm in April. In females the modal size was at 121-125 mm in January and it progressed to 126-130 mm in March. Smaller females having the modal size 111-115 mm were observed in April. The occurrence of smaller sizes in both males and females in the month of April indicated an intensive recruitment of the species into the fishing ground. In the post-monsoon fishery, the modal sizes of males and females were at 131-135 mm and 141-145 mm respectively. The pattern of size distribution of *P. merguiensis* was similar to that of *M. affinis*. Larger prawns predominated the catches in the begining of the year and as the season advanced they were replaced by smaller specimens. In December when the highest catch of the species was recorded, the mode in the size frequency distribution was at 121-125 mm for the males and 131-135 mm for the females. In *P. stylifera* the main size groups were at 86-95 mm for males and 96-105 mm in females.

The inshore prawn fishery in the first half of the year was negligible but it was active during the monsoon months-July to September. The estimated catch of prawns landed by the shore-seines was 3.7 tonnes. *M. dobsoni*, *M. monoceros* and *P. stylifera* were the species contributing to the fisheries in the first half of the year. The former two species were absent in the catches of the second half and their place was taken by *P. merguiensis* and *P. monodon*. Large sized *P. mergniensis* in the modal sizes of 171-175 mm for females and 161- 165 mm for males formed the major portion of the catches.. The sizes of *P. stylifera* obtained in the inshore regions were similar to those obtained in the mechanised vessels. The sizes of *P. monodon* ranged from 116-240 mm.

At Kagal the fishery for juvenile prawns was of lesser magnitude when compared to that of the previous year. The total prawn landings from this estuarine region was estimated to be 6.5 tonnes. Juveniles of *M. dobsoni* (26-60 mm), *M. monoceros* (26-85 mm) and *P. merguiensis* formed the bulk of the catch. The size distribution of these specimens indicated intensive recruitment of juveniles into the estuary at two periods; one in May and the other in November-December. In the case of *M. monoceros*, recruitment of smaller specimens was also observed in August.

Mangalore: The shrimp trawlers stationed at Mangalore landed an estimated catch of 1579 tonnes of prawns. The landings in the second half of the year were comparatively poor, but the average catch per fishing trip was 77.0 Kg and 52.7 kg respectively in the first and second half of the the year. These showed improvement over the average catch of the corresponding period of the previous year. At Malpe the total prawn catch was 111.8 tonnes. Although the total catch of prawns landed in the second half of the year was more than three times the landings of the same period of the last year, the catch rate was however low, being 11.9 kg. The catch per fishing trip, in the first half of the year, was 33.8 kg. As usual, *M. dobsoni*, *P. stylifera* and *M. affinis* were the important species supporting the prawn fishery of this area. For both the sexes of *M. dobsoni*, bimodal size distribution was observed; dominant size modes for males being 81-85 mm and 101-105 mm in the first half, 71-75 mm and 101-105 mm in the second half and for females 86-90 mm and 101-105 mm in the first half and 91-95 mm and 116-120 mm in the second half. In *P. stylifera* also two modes for both sexes, a smaller one at 71—80 mm for males and 91—95 mm for females and a larger one at 101—105 mm for both sexes, were noticed. The size distribution of *M. affinis* showed multiple modes between 116—120 mm and 150—160 mm in the first half of the year and a single mode at 131—135 mm for males and 146—150 mm for females in the later half of the year.

The inshore prawn fishery at this centre was an utter failure during the period under report. The quantity of prawns landed by indigenous gear was estimated at a very low figure of 4 tonnes. *M. dobsoni* was the dominant species supporting the fishery. *Penaeus* spp. were also encountered in the first 3 months of the year. During monsoon large sized *M. dobsoni* (101—115) formed a major portion of the catch.

In the inshore plankton, the eggs and larval forms of penaeid prawns were present throughout the first half of the year and in the later part of November. They were more common during February to May in the 8 fathom regions. Although no significant deviation in the general pattern of temperature variation was observed the salinity values during this period were generally low.

Calicut: The total prawn catch landed by mechanised vessels was estimated at 444 tonnes during the year under report. *M. dobsoni*,

P. stylifera and *M. affinis* were the dominant species supporting the fishery at this centre. *P. indicus* and *P. monodon* were also caught is small quantities in the first half of the year. The catches of *M. dobsoni* consisted largely of adults having a modal size at 71-80mm and with several females in mature stages. In *P. stylifera* the dominant size was at 96–100 mm for females and 76–85 mm for males. *M. affinis* largely included smaller specimens in the size group 76–85 mm in the first half and larger specimens in 150–160 mm in the second half.

The inshore prawn fishery was comparatively better during the year. About 666 tonnes of prawns were landed by the indigenous gears at Calicut and the catch was composed of *M. dobsoni, M. affinis, P. stylifera* and *P. indicus*. The size of all these prawns were more or less similar to those obtained in the catches of the mechanised vessels.

The estimated prawn landings from the stake net fishery of the Korapuzha estuary were 17 tonnes. Juveniles of *M. monoceros, M. dobsoni P. indicus* and *P. monodon* were the main species in the catch. Studies on the migration of post-larval and juvenile prawns into the estuary showed that there was a gradual increase in the occurrence of these stages from the first week of October till the end of December.

Cochin: The commercial trawlers based at Cochin landed an estimated catch of 1064 tonnes of prawns during the year. The total landings in the first half of the year was almost double of what was landed in the second half, and the catch-per-hour was 16.83 Kg/hr and 15.36 Kg/hr in the first and second half respectively. Better landings were observed in January, May, October and December. *M.dobsoni, P. stylifera* and *M. affinis* were the dominant species contributing to the fishery. These were supported by *P. indicus* and *M. monoceros* during some months of the year.

The principal size modes of *M. dobsoni* in the first half of the year were between 76-85 mm in males and 81--05 mm in females; in the second half, it ranged from 51--55 mm to 116–120 mm in both sexes with the prominant mode at 66--70 mm and 76–80 mm. In *P. stylifera* the modal size ranged from 76--80 mm to 111–115 mm. In *M. affinis* 126--135 mm size groups in males and 136--140 mm in females formed the modes in the beginning of the year, while smaller size group at 121--130 mm constituted the majority in the rest of the period.

Prawn catches landed by the vessels of the New India Fisheries Co. Ltd. Cochin were composed of *M. dobsoni, P. indicus, P. monodon, P. semisulcatus, M. affinis* and *M. monoceros*. In July the fishing operations were carried out off Cochin at depths 7--12 metres and in August off Manapad at 25--30 metres. In the catches obtained off Cochin, *M. dobsoni* domimated with a modal size at 91--95 mm for males and 101--110 mm for females. *P. indicus* was the predominant species obtained from Manapad and its dominant modes were 161--165 mm for males and 171--190 mm for females. Most of the females caught were in advanced stages of maturity.

The inshore prawn fishery at Manassery was active only during the monsoon months, June to September, when an estimated catch of 214 tonnes was landed. The pre and post monsoon fishery for prawns were negligible. *M. dobsoni* contributed a major portion of the catches and its modal size ranged from 46--50 mm to 111--115 mm. *M. affinis* (51--55 to 110--115 mm), *P. indicus* (156--160 mm to 171--175mm) and *M. monoceros* (76-80 mm) were the other species caught occasionally.

The stake net fishery at Thopumpady in the backwaters of Cochin landed an estimated catch of 79 tonnes, much of which was caught in the first half of the year. Over 75% of the catch was composed of juveniles of *M. dobsoni* having modal sizes between 46--50 mm and 66--70 mm. Other species present in the catches were *P. indicus, P. monoceros* and *P. affiniss*. A comparison of the prawn catches of the stake net at Thopumpady and Thevara revealed that in the latter centre the prawn catches were better in the second half of the year, the catch/unit varying from 5.4 kg to 8.5 kg.

Mandapam: No data on commercial and exploratory catches could be collected from this centre. Some observations on *Penaeus semisulcatus* were however made. The mature specimens of this species occurred in all the months indicating a prolonged spawning season. Peak spawning was however noticed in June-July. No other data on this species or on its fishery have been observed.

Madras: Prawn fishery at Pulicat lake was extremely poor during year. In the first half of the year, an estimated total catch of 135 tonnes of prawns were landed and in the second half severe draught conditions at first and subsequently heavy rains impeded the fishing activities of the lake. *P. indicus* (46--160 mm) was the dominant species throughout except in July and August when *M. monoceros* (66--115 mm) and *M. dobsoni* (46--85 mm) predominated the catches.

The offshore prawn fishery of the mechanised vessels at Royapuram was good during the first half of the year, when an estimated catch of 90 tonnes of prawns was landed. In the second half of the year fishing operations could be carried out less frequently due to bad weather. *P. indicus* was the dominant species contributing to the fishery. Large sized prawns measuring above 180 mm were generally caught during November—December.

At Triplicane a total of 15 tonnes of prawns were landed during the second half of the year. *M. dobsoni, M. monoceros, P. indicus* and *P. maxillipedo* were the species of prawns found in the catches.

Kakinada: The offshore prawn fishery at this centre landed 273 tonnes of prawns. It was generally observed that prawns were not so abundant in the deeper waters beyond 15 fathoms. However, large sized *M. monoceros* (130–170 mm) and *P. indicus* (170-180) were obtained from

deeper regions. In the shallower waters *P. monodon*, *M. dobsoni*, *M. affinis*, and *M. brevicornis* were the common species.

The inshore prawn fishery at Dummulupetta and Yanam was comparatively poor, but at Venketapalam it was very successful. The estimated catch of prawns from these landing centres were 9.22 and 241 tonnes respectively. Juveniles of *M. monoceros*, *P. indicus*, *P. monodon*, *M. dobsoni* and *M. brevicornis* constituted the catch.

Fishery and biology of the giant fresh-water prawn

Macrobrachium rosenbergii:

The species was so scarce in the normal fishing areas that it was difficult to obtain even material for study. One berried female specimen obtained from the stake net collection from Thopumpady was brought alive to the laboratory and kept in the aquarium tank. The eggs hatched into the first zoea stage and within 8 days the larvae underwent three moulting and reached 4th zoea stage. Mixed algal culture were given as food to the larvae. Further studies are in progress.

Larval history of penaeid prawns:

The distribution and abundance of the different larval stages of the commercially important penaeid prawns in the inshore waters of Cochin during the year were similar to those of the previous year. Eggs and different nauplial stages belonging to *M. dobsoni* were seen in January, February and November-December. Mysis and post-larval stages of the species were abundant in the inshore waters during the same period. Protozoeal and mysis stages of *P. stylifera* were chiefly found in March and December. In May a huge swarm of post-larvae belouging to *M. monoceros* along with a considerable number of the larvae of *M. affinis* and *P. indicus* were observed. However, the larvae of all these species were poorly represented in the inshore waters in the second half of the year. From the abundance it would appear that the recruitment of larvae into the inshore waters was of lesser magnitude in June. The principal peak recruitment of the larvae, generally taking place in October-December of every year was delayed and commenced only from November.

A correlation between temperature and the abundance of larvae showed a direct relationship; as the number of larvae increased with a rise in temperature from 28° C to 30 ° C during the second half of the year, the larvae also increased.

In the backwaters of Cochin, late mysis and post-larvae of *M. dobsoni* occurred throughout the period. Post-larvae of *P. indicus* were encountered occasionally in March, April, May, and December. The larval stages of *M. monoceros* were rare in the surface collections. In general the rate of recruitment of penaeid larvae in the first half of the year was relatively

deeper regions. In the shallower waters *P. monodon*, *M. dobsoni*, *M. affinis*, and *M. brevicornis* were the common species.

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The distribution and abundance of the different larval stages of the commercially important penaeid prawns in the inshore waters of Cochin during the year were similar to those of the previous year. Eggs and different nauplial stages belonging to *M. dobsoni* were seen in January, February and November-December. Mysis and post-larval stages of the species were abundant in the inshore waters during the same period. Protozoeal and mysis stages of *P. stylifera* were chiefly found in March and December. In May a huge swarm of post-larvae belouging to *M. monoceros* along with a considerable number of the larvae of *M. affinis* and *P. indicus* were observed. However, the larvae of all these species were poorly represented in the inshore waters in the second half of the year. From the abundance it would appear that the recruitment of larvae into the inshore waters was of lesser magnitude in June. The principal peak recruitment of the larvae, generally taking place in October-December of every year was delayed and commenced only from November.

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high and in the second half it was almost similar to that of the corresponding period during the previous year.

Assessment of the rate of to and fro migration of the post-larvae and juvenile prawns in Cochin backwaters: Studies were continued by regular collection of samples from the experimental stake net operations. The rate of recruitment, as seen from the stake net catches, seemed to decrease from January onwards. Considerable increase was noticed in June and August. Smaller sized prawns appeared from March to June and October to December.

Experimental fishing carried out by trial net operations at fixed stations in the backwaters of Cochin revealed that juvenile prawns varied from 0.2 to 96.5 per cent. Comparison of the catch rate obtained during different phases of the tide showed higher catches during the ebb tide, indicating a high rate of migration from the backwaters. Juveniles of *M. affinis*, *M. dobsoni*, *M. monoceros*, *P. semisulcatus* and *P. indicus* were the species generally formed. The interesting feature in the species composition and their succession was that *P. semisulcatus*, which was common from January to June, disappeared from July and reappeared again in December. This indicated that the species migrates into more saline waters with the onset of monsoon and recolonises the backwaters when the salinity increases considerably. Recruitment of juveniles into the backwaters as indicated by the occurrence of small-sized specimens showed that in *M. dobsoni* it continued from September onwards, while in the other two species of the same genus it occurred more readily during July-September.

Deep-Sea prawn resources investigation:

The vessels belonging to the Indo-Norwegian Project continued the deep water explorations off the southwest coast of India. In January 'Klaus Sunnana' landed a total quantity of 3998 kg of deep-sea prawns in 42 hauls from depths between 130 to 220 fathoms. During the second half of the year, two vessels 'Tuna' and 'Velameen' fished in the Quilon bank at depths 100-250 fathoms and landed more than 11.5 tonnes of prawns in 213 hauls expending a total effort of 177.2 hours. The catches mainly consisted of *Heterocarpus wood-masoni*, *H. gibbosus*, *Parapandalus spinipes*, *Plesionika martia*, *P. ensis*, *Metapenaeopsis andamanensis*, *Aristeus semidentatus*, *Aristaeomorpha wood-masoni* and *Penaepsis rectacuta*. The size, sex ratio and percentages of the constituent species were similar to that of the previous records.

Paddy field prawn culture:

Studies based on the catches af two fields at Vypeen Is were continued. *Metapenaeus dobsoni* was found to form the bulk of the culture fields of Vypeen Island. The modal sizes of the species were 46--50 mm and 61--65 mm in males and 51--55 mm 66--70 mm in females. The bigger size range outnumbered the smaller ones. *M. monoceros* and *P. indicus* were

also recorded in poor numbers. In November a maturing specimen of total length 169 mm was observed in the catches of Edavanakad paddy field.

LOBSTER FISHERY INVESTIGATIONS

Rock lobster *Panulirus homarus:* During the year there was a considerable increase in the quantity of lobster export from the country. The lobster tails exported during the year amounted to 529 tonnes, as against 297 tonnes during the previous year.

The fishery in the main lobster producing area viz. Kanyakumari District, was active in the first and last quarter of the year. The estimated catch of lobsters at the three observations centres-Colachel, Muttam and Manakkudy-amounted to 131,000 lobsters. The catch was exclusively composed of *Panulirus homarus*. The modal size of the species at Colachel varied between 160--170 mm and 210--220 mm while at Muttam smaller specimens (150--160 mm) dominated the catches.

Deep-water lobsters *Puerulus sewelli:* The most significant development that has taken place in the field of capture fishery of the country during the year was the discovery of a trawling area from where 'Klaus Sunnana', one of the Indo-Norwegian Project vessels, began to land very lange quantities of deep-water spiny lobster *Puerulus sewelli*. This species which was hitherto not known to occur in any part of the world in significant quantities has emerged as a commercially exploitable marine resource. Subsequently other trawlers, 'Bluefin' of the Central Institute of Fisheries Operatives and 'Sudha' of the New India Fisheries Ltd., Cochin also operated in the same grounds and landed considerable quantities of spiny lobster. This lobster ground is located at 95 to 120 fathoms depth on the continental slope between Quilon and Cochin. Between January and June 'Klaus Sunnana' took 217 hauls spending 238.75 hours in actual trawling and landed 63.748 tonnes of spiny lobster. The catch rate worked out to 294 kg/haul and 188.35 kg/hour. However, in the second half of the year 8.083 tonnes of lobsters were landed at a catch rate of 26.77 kg/hour.

The sizes of the lobsters ranged from 91--95 mm to 206--210 mm in total length. In all the months the modal sizes were between 151--175 mm. Smaller specimens, measuring below 135 mm, occurred in January and July--September. Berried females occurred throughout the period but larger numbers of them were observed during February-April and November—December. Females dominated the males in number in all the months except in July. Most of the lobsters caught during July-September were soft indicating intensive moulting activity of the species during that period.

CRAB FISHERY INVESTIGATIONS

Cochin: Crabs form a minor fishery in the backwaters of Cochin. The perceneage of crabs in the departmental try-net catches varied from nil to 88% of the total catches. *Portunus pelagicus* and *Scylla serrata* were the

high and in the second half it was almost similar to that of the corresponding period during the previous year.

Assessment of the rate of to and fro migration of the post-larvae and juvenile prawns in Cochin backwaters: Studies were continued by regular collection of samples from the experimental stake net operations. The rate of recruitment, as seen from the stake net catches, seemed to decrease from January onwards. Considerable increase was noticed in June and August. Smaller sized prawns appeared from March to June and October to December.

Experimental fishing carried out by trial net operations at fixed stations in the backwaters of Cochin revealed that juvenile prawns varied from 0.2 to 96.5 per cent. Comparison of the catch rate obtained during different phases of the tide showed higher catches during the ebb tide, indicating a high rate of migration from the backwaters. Juveniles of *M. affinis*, *M. dobsoni*, *M. monoceros*, *P. semisulcatus* and *P. indicus* were the species generally formed. The interesting feature in the species composition and their succession was that *P. semisulcatus*, which was common from January to June, disappeared from July and reappeared again in December. This indicated that the species migrates into more saline waters with the onset of monsoon and recolonises the backwaters when the salinity increases considerably. Recruitment of juveniles into the backwaters as indicated by the occurrence of small-sized specimens showed that in *M. dobsoni* it continued from September onwards, while in the other two species of the same genus it occurred more readily during July-September.

Deep-Sea prawn resources investigation:

The vessels belonging to the Indo-Norwegian Project continued the deep water explorations off the southwest coast of India. In January 'Klaus Sunnana' landed a total quantity of 3998 kg of deep-sea prawns in 42 hauls from depths between 130 to 220 fathoms. During the second half of the year, two vessels 'Tuna' and 'Velameen' fished in the Quilon bank at depths 100-250 fathoms and landed more than 11.5 tonnes of prawns in 213 hauls expending a total effort of 177.2 hours. The catches mainly consisted of *Heterocarpus wood-masoni*, *H. gibbosus*, *Parapandalus spinipes*, *Plesionika martia*, *P. ensis*, *Metapenaeopsis andamanensis*, *Aristeus semidentatus*, *Aristaeomorpha wood-masoni* and *Penaepsis rectacuta*. The size, sex ratio and percentages of the constituent species were similar to that of the previous records.

Paddy field prawn culture:

Studies based on the catches af two fields at Vypeen Is were continued. *Metapenaeus dobsoni* was found to form the bulk of the culture fields of Vypeen Island. The modal sizes of the species were 46-50 mm and 61--65 mm in males and 51--55 mm 66--70 mm in females. The bigger size range outnumbered the smaller ones. *M. monoceros* and *P. indicus* were

also recorded in poor numbers. In November a maturing specimen of total length 169 mm was observed in the catches of Edavanakad paddy field.

LOBSTER FISHERY INVESTIGATIONS

Rock lobster *Panulirus homarus:* During the year there was a considerable increase in the quantity of lobster export from the country. The lobster tails exported during the year amounted to 529 tonnes, as against 297 tonnes during the previous year.

The fishery in the main lobster producing area viz. Kanyakumari District, was active in the first and last quarter of the year. The estimated catch of lobsters at the three observations centres-Colachel, Muttam and Manakkudy-amounted to 131,000 lobsters. The catch was exclusively composed of *Panulirus homarus.* The modal size of the species at Colachel varied between 160--170 mm and 210--220 mm while at Muttam smaller specimens (150--160 mm) dominated the catches.

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two species of commercially important edible crabs occurring in the catches. *S. serrata* occurred throughout the year, while *P. pelagicus* was found from January to June and November to December. At the onset of monsoon in June the species migrated to more saline waters and appeared again in November when the salinity of the backwater increased considerably.

Large sized *P. pelagicus*, measuring 100-150 mm across carapace, were generally encountered in the first half of the year. Berried specimens were observed in the catches from February onwards. However, the intensity of their ocurrence was less in the backwaters than in the adjoining sea. When the crabs reappeared in the backwaters in November, they were smaller in size and measured between 31-45 mm indicating a newly recruited population. Rearing experiments conducted in the laboratory showed a growth increment of 9-10 mm per single moult in specimens of size range 30-35 mm across the carapace.

Kakinada : The crab fishery investigations at this centre commenced from the second half of this year. Crab fishery is of considerable significance at this centre and is spread out in the estuarine regions of the Godavari river mouth. At Yetimoga a total quantity of 44.8 tonnes of crab were landed during the period in the crab nets. The average catch rate amounted to 46.65 kg per unit. *P. pelagicus* (96.5 %) and *S. serrata* (3.5 %) were the species landed. The rate of yield of crabs gradually increased from July to October and thereafter showed a decline. The size range of *P. pelagicus* varied from 130 to 170 mm. Berried females were observed in all the months indicating protracted breeding but the incidence of berried females were high in October and November. *S. serrata* were common in the last quarter of the year and their sizes ranged from 150 mm to 220 mm in carapace width.

At Venkatapalam bait lines landed 4.7 tonnes of *S. serrata* alone during this half year period. This catch consisted mostly mature and immature specimens. Berried females were never obtained in bait lines but they were obtained in other gears at the same centre.

MOLLUSCAN FISHERIES

The schemes on the underwater ecological studies of the sea bottom off Tuticorin and the estimation of population of the pearl oysters and chanks were started in January 1969 in collaboration with the Madras State Fisheries Department. The work has been approved for a five year period and involves observations to be made by means of SCUBA. The earlier survey carried out has enabled us to understand the general topographical features of the sea-bottom as also the faunistic composition of different localities. A detailed study was therefore undertaken.

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For the ecological studies, the region from Manapad to Tuticorin, was divided into 4 zones, and stations were fixed in the chank and pearl beds in all the zones as follows:

	Shoreward	*Offshore*
Zone 1. Vaipar area	Rocky station 1 A	Station 1 B
	Sandy 1 a	Sandy 1 b
Zone 2. Tuticorin area	Rocky station 2 A	Station 2 B
	Sandy 2 a	Sandy 2 b
Zone 3. Pinnakayal area	Rocky station 3 A	Station 3 B
	Sandy 3 a	Sandy 3 b
Zone 4. Tiruchendur area	Rocky station 4 A	Station 4 B
	Sandy 4 a	Sandy 4 b

The observations at the above 16 stations give an indication of not only the distribution pattern of the fauna and flora but also the density of the population of pearl oysters and chanks.

Data collection and observations were possible from January to April and October to December only, as in other months the weather and sea conditions became unsuitable for diving. Therefore, only 25 diving operations could be undertaken.

The shoreward sandy and rocky stations in zones 1 and 2 and the offshore sandy and rocky stations in zone 2 were investigated during the year. Because of the lack of clarity, observations in the offshore stations in zone 1 could not be made. The following are the results of observations made.

Zone 1 (off Vaipar) Inshore formation-Station 1 A (rocky): An estimated 730 sq m of rocky bottom off Vaipar was sampled and a good population of pearl oyster spat of *Pinctada furcata* was observed. This species was under heavy competition with *Modiolus* sp. The spat ranged in size from 13--45 mm in length, the majority being 25–30 mm size group, thereby showing that the oysters had settled only very recently. Many oysters were found dead, but good chances seem to exist for the remaining oysters to survive, because of the dwindling *Modiolus* population also. Each sq metre of the rocky bottom was estimated to contain 53 live oysters and 20 dead shells. The number of *Modiolus* sp. in the same area was counted as 4000, on an average, of which 60% were dead shells.

Since the shoreward rocky formation in this zone is continuous up to zone 2 it was thought necessary to see whether the oyster population was equally distributed in other areas also. Hence a second station further south in between zone 2 and zone 1 was also sampled. But at this station

the density was rather poor there being only 17 live oysters in 1 sq m. But the *Modilolus* sp.was found in enormous numbers amounting to more than 7000/ sq m. This might have led to a deleterious effect for the oyster population in thi area.

The station A had a flat rock and laminated bottom with pits and crevices. This type of bottom provided a hard anchorage for the spat. The fauna was poor. Two species of sponges, one species of live coral and 2 species of live crinoids were very prominent. The flora was also poor.

Inshore sandy bottom - Station 1 a (sandy): The sandy stretch at 14–17 m depth was investigated for the chank population. Chanks were found at 16 metres. The ' drift method' of counting was done in this area. Three sample counts were made along the north, middle and south areas. In an area of 1500 sq m an average of 41 chanks were seen.

Zone 2 (off Tuticorin) - Inshore formation Station 2 A (Paar): The rocky substratum showed an evidence of settlement of pearl oyster spat as early as in July 1969, but the density was much thinner than that of zone 1, (4 oysters in 1 sq m). The same station was investigated later in the year and it was found the oysters had all died due to some reason which is difficult to explain.

The flora in this area was luxurious, predominantly consisting of *Sargassum* sp. The fauna was mostly of sponges (2 species) and *Pentaceraster lincki.*

Inshore sandy area - Station 2 a (Sandy): One stretch of sandy bottom where chanks thrive was also taken up for estimating the density of chank population. The clarity in the area was so poor that a proper estimate could not be made. Further this area had been exploited by commercial fishermen in earlier month. It is proposed to study the area during the next favourable season.

Zone 2 Offshore formation-Station 2 B (Paar): Two sample stations were studied during the later half of the year in this area. Oyster had settled in this area. Spat ranging in size from 10 to 45 mm were seen indicating a recent spat-fall during the north-east monsoon period or perhaps prior to it. Majority of the spat ranged from 15-20 mm in size. *Modiolos* sp. were absent. This area requires futher investigations in March 1970.

Offshore sandy area-Station 2 b (sandy): Population density of chank was studied in this extensive ground at only one sampling station. A total of 72 chanks were counted in 1500 sq m. The population is estimated to be about 550,000, since the ground has an area of 13 sq km approximately.

Further work, it is hoped, will be continued in the offshore regions of zone 1 during next year.

MARINE BIOLOGY AND OCEANOGRAPHY

PRIMARY PRODUCTION STUDIES

Primary production experiments using C^{14}, were conducted at 10 stations during two cruises of R. V. Varuna in March and April. The first cruises was in the Wadge Bank area and the second in the Laccadive Sea. The rate of production at all the stations was of a lower order 0.5 $gC/m^2/$ day. Further experiments could not be carried out due to the suspension of cruises by the research vessel. However, *in vitro* experiments were conducted with cultures grown in the laboratory. These experiments were aimed at estimating the variability introduced by different techniques in the magnitude of organic production values.

During the period, the primary productivity and potential resources of the Indian Ocean were studied in a general way. For this purpose, all the available data from various cruise reports were used to get a general picture of the productivity of the region, between 20° and 120°E longitudes and upto 45° S latitude. From these, the annual rates were computed for the western and eastern sectors of the Indian Ocean. The potential harvest in terms of fish from both the sectors and also from the continental shelf region was estimated using data on basic production and different theoretical approaches. These estimates were compared with the exploratory fishing data for the different regions. According to these estimates the potential yield approximately 11 million tonnes of fish.

Theoretical studies on the extinction coefficient of sea water were made. An equation was developed from which an average extinction coefficient could be determined by the aid of Secchi disc observations in the sea. The analysis clarified the doubts regarding the use of "Secchi disc constant". The analysis also revealed the necessity to calibrate the Secchi disc according to the visual capacity of the observer.

PLANKTON STUDIES

Studies on the Dinophyceae of the Indian Seas:

The work on the genus *Peridinium* Ehrenberg has been completed and the manuscript and figures have been edited and sent to the press.

Investigations on the plankton of the inshore waters:

Calicut: During the year regular phytoplankton samples were collected except during the months July to August. The data collected are given in accompanying tables.

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Displacement volume, dry weight etc. of phytoplankton at Calicut

1969		Disp. volume in cc	Dry wt (gm)	Harvey units
January	S:	22.25	4.12	1050
	V:	3.1	1.29	—
February	S:	18.15	2.09	13600
	V:	5.45	0.93	—
March	S:	10.60	2.33	3250
	V:	2.33	1.07	—
April	S:	11.10	3.55	175
	V:	2.55	1.68	—
May	S:	34.00	3.40	400
	V:	2.30	1.49	—
June to August		No collections		
September	S:	5·0	0.74	—
	V:	0.5	0.34	—
October	S:	6.2	1.16	5.5
	V:	1.52	0.68	—
November	S:	10.95	1.26	—
	V:	1.72	0.46	—
December	S:	38.0	2.9	10.0
	V:	4.1	0.49	—

S: Surface haul V: Vertical haul

Cell count in numbers of phytoplankton at Calicut

1969		Diatoms	Dinophyceae	Cyanophyceae
January	S:	34543125	51000	—
	V:	5411291	11375	625
February	S:	991637	55375	2500
	V:	2663275	13500	—
March	S:	535625	48750	53750
	V:	77399	3875	12500
April	S:	303125	34750	10625
	V:	237625	26250	62900
May	S:	368375	60750	1380000
	V:	172250	16250	—
June to Aug.		No samples	—	—

September	S:	560149000	—	—
	V:	275038500	2500	—
October	S:	387618	264061	1500
	V:	77368	6185	250
November	S:	553686	338062	15625
	V:	30182	3497595	1687
December	S:	126948800	131778290	10000
	V:	35742	109829	6666

S: Surface haul V: Vertical haul

Phytoplankters were abundant from January to March. Among the phytoplankters occurring during September to December, species of *Actinoptychus*, *Rhizosolenia*, *Fragilaria*, *Chaetoceros*, *Nitzschia*, *Ceratium* and *Peridinium* were very abundant. There was an extensive bloom of *Ornithocercus magnificus* in the month of December.

Mangalore: Plankton and water samples were collected from 4 and 8 fathom stations off Ullal. Due to unfavourable weather conditions collections could not be made during the months of June to August. The plankton displacement volume was higher during the January–March quarter as compared to that of the April–June quarter and also it was high during September. The maximum plankton volume of 63.0 ml was recorded in the first week of March from 4 fathom upwards. The monthly averages of plankton volume are given below.

Month	*4 F Surface*	*8 F Surface*
January	27.20 ml	31.40 ml
February	32.00 ,,	54.50 ,,
March	29.50 ,,	24.74 ,,
April	8.67 ,,	10.33 ,,
May	18.00 ,,	—
June	No data	—
July to August	No data	—
September	35.00 ml	—
October	13.00 ,,	56.00 ml
November	5.00 ,,	18.00 ,,
December	7.33 ,,	13.33 ,,

Plankton from 4 fathom to the surface: Among the dinoflagellates only *Ceratium* sp. were observed in moderate numbers throughout the half year. The "swarming" of *Ceratium* was observed in the second and third week of February. Species of *Peridinium*, *Dinophysis* and *Ornithocercus* were extremely rare.

The diatoms were present in good numbers during January and March. The most common diatoms were the species of *Chaetoceros*, *Streptotheca*, *Coscinodiscus*, *Rhizosolenia* and *Bellarochea*. The other diatom species present in low numbers were *Biddulphia*, *Stephanophyxis*, *Nitzschia* and *Hemidicus*. The blue green alga *Trichodesmium* sp. was present in moderate numbers during tne third week of January and it was again present in moderate quantities during April and May.

The phytoplankton was generally poor during second half of the year. The diatoms were observed in very few numbers. The most common diatoms were the species of *Chaetoceros*, *Coscinodiscus*, and *Rhizosolenia*. The other diatom species noticed in very few numbers were *Biddulphia*, *Nitzchia*, *Ditylum and Plantoniella*. *Fragilaria oceanica* was present in a few numbers during the third week of December.

Among the dinoflagellates, *Noctiluca miliaris* was noticed in moderate numbers during the first week of September. *Ceratium* sp. were present in good numbers during November and December. *Peridinium* sp. and *Prorocentrum* sp. were extremely rare.

Plankton from 8 fathom to surface:- The diatoms were present in good numbers during January and March. The blue geen alga *Trichodesmium* sp. was observed in good numbers in January and its "bloom" was noticed in the first week of April.

Port Blair: During the first half of the year twentyfive plankton samples were collected from North Bay, Port Blair by towing a ½ metre diameter organdie net at the surface for 15 minutes. The volume of plankton during this period varied from 2 ml to 92 ml. The lowest volume was recorded on 12-2-'69 and the highest volume on 8-1-'69. The surface waters from January to March were fairly rich and comparatively poor during the latter half of the year. The salient features in the plankton during this period were as follows :-

1. A multispecies phytoplankton bloom occurred on 15-1-'69 and 26-3-'69 consisting of *Rhizosolenia*, *Bacteriastrum*, *Coscinodiscus*, *Melosira Ceratium*, *Biddulphia*, *Thalassiosira*.

During the second half year, twenty seven plankton samples were collected and analysed. The volume of plankton for a fifteen minutes surface haul during this period varied from 5 ml to 64 ml. The lowest volume of 5 ml was recorded on 30-7-'69, and the highest volume of 64 ml on 19-11-'69. The average volume of plankton was lowest in August and December. Generally the surface water was fairly rich in organisms during the latter half of the period. A minor phytoplankton bloom occurred on 17-12-'69, consisting of *Chaetoceros*, *Bacteriastrum*, *Biddulphia*, *Rhizosolenia* and *Melosira*.

Average values of temperature, salinity and volume of plankton a Marine Bay, Port Blair, for the year are given below.

Months	*Temperature (°C)*	*Salinity (°/$_{oo}$)*	*Volume (ml)*
January	27.7	31.39	56.5
February	27.7	32.05	47.5
March	29.1	32.22	61.7
April	30.7	32.78	11.7
May	30.0	33.16	10.5
June	28.4	30.78	27.0
July	28.0	30.64	21.0
August	28.3	31.60	18.0
September	28.0	29.91	23.0
October	29.3	30.29	27.0
November	29.0	30.22	27.0
December	28.0	32.25	29.0

Diatoms from the oceanic waters off the west coast of India:

During the year, the analysis of the old collection of R. V. Varuna was in progress. Samples of cruise numbers V37 to V45 and V47 to V51 were used for identifying the diatoms. The important diatoms identified include different species of *Chaetoceros, Bacteriastrum, Coscinodiscus, Biddulphia* and *Rhizosolenia.* A few rare diatoms such as *Coscinodiscus reniformis, Hemidiscus cuneiformis, Chaetoceros tetrastrichon* and *Asteromphalus arachne* formed an important feature of the samples of cruises V42 and V45. Auxospore formation of *Ditylum brightwelli* and 'spore' formation of *Streptotheca* sp. were also observed in the samples of V45. Occurrence at a 'bloom' of *Rhizosolenia* sp. in the samples of V51, particularly at station numbers 2247 and 2249 was also noted. Camera-lucida drawings of the identified diatoms were made during this period. Further analysis and identification of the diatoms from the samples of R. V. Varuna are being continued.

Investigations on the standing crop of zooplankton off the southwest coast of India and the Laccadive Sea:

Displacement volumes of zooplankton samples have been completed for all the samples collected upto the end of December 1969. Based on the Indian Ocean standard net collections, the preparation of charts showing the standing crop of the zooplankton in space and time is under progress for the period May 1963 to December 1969.

On the larval development and abundance of the heterostomatid fish, *Chascanopsetta lugubris* Alcock from the deep neritic waters off the west coast of India :

As a result of extensive trawlings carried out from the continental shelf edge and the upper continental slope, it is seen that only one species of the deep sea flatfish belonging to the genus *Chascanopsetta* and species *C. lugubris* Alcock, occurs off the south west coast of India. It has been possible to identify the larval stages of this species from the R. V. Varuna plankton collections. In addition, the maturity, fecundity and spawning periodicity of this species is being investigated, as this information will be necessary for a proper assessment of the larval abundance and recruitment. Ova have been counted in 18 ovaries and these show variations between 100520 and 542915 ova (Average count - 236488 ova).

On the occurrence and distribution of larvae of fishes of the family Chlorophthalmidae from the west coast of India :

By extensive trawling surveys from the continental shelf edge and the upper continental slope, it has been possible to obtain only two species of *Chlorophthalmus*, namely, *C. agassizi* and *C. corniger*. The larvae of *Chlorophthalmus* have been identified from the R. V. Varuna plankton collections. The maturity, fecundity and spawning periodicity of these two species which have a bearing on the larval abundance and recruitment is also being investigated. Fecundity counts were as follows:

Species	*No.*	*Min. ova counts*	*Max. ova counts*	*Average*
C. agassizi	25	17324	178772	73688
C. corniger	6	58992	151796	102719

Cephalopoda with special reference to pelagic squids, their taxonomy, distribution and abundance:

Developmental stages of the oceanic squid, *Symplectoteuthis oualaniensis* have been identified from the plankton and drawings have been made. In view of the potential importance of this species in fisheries, a detailed study of the adults in the collections is also being carried out.

Investigations on the reproduction and life-history of Euphausiaceae:

During the first half year, sixty plankton samples were made with a standard net. These were examined and the euphausiids from them were sorted out and studied.

Besides the adult specimens, a good number of larvae of different stages were also present in the collections. Morphological and taxonomical characters of two species of the genera *Nematoscelis* and *Stylocheiron* have been completed.

During the second half year, sub-sorting of euphausiids from the standard net collections was continued. Diagrams of the morphological and anatomical features of a few adult specimens of euphausiids have been completed. Detailed investigations on the life-history stages of *Euphausis diomedeae* and other abundant species of euphausiids in the tropical Indian Ocean are in progress. All the life-history stages of *E. diomedeae* from post-naupliar stage to the adult stage have been identified from the plankton and detailed studies have been made on them. Detailed diagrams and descriptions of each stage have also been completed.

Investigations on the biology of Chaetognatha:

During the year, 53 plankton samples were collected during the cruises of R. V. Varuna along the west coast of India and the Laccadive Seas. These were examined and chaetognaths from these samples were sorted and identified. While examining these samples, two more species of *Sagitta* have been identified. They are *Sagitta ferox* Doncaster (1903) and *S. hexaptera* d'Orbigny (1834). *S. ferox* is closely allied to *S. robusta* Doncaster (1903) while *S. ferox* can be easily separted from *S. robusta* by the structure and nature of the seminal vesicles, arrangement of the ova in the ovaries and the length of the anterior fin- *S. hexaptera* resembles *S. inflata,* but the former is larger in size and has only a fewer anterior and posterior teeth.

During this period an illustrated key for the identification of the Indian Ocean chaetognaths, numbering 33 species, was prepared. The key includes the following genera ;

1.	*Sagitta*	(24)	The numbers in brackets indicate the number of species.
2.	*Pterosagitta*	(1)	
3.	*Krohnitta*	(2)	
4.	*Eukrohnia*	(5)	
5.	*Spadella*	(1)	

While preparing the key, special attention has been given to the dependable characters such as eyes, seminal veiscles, ovaries, lateral fins, collarette, ventral ganglion etc. Moreover, the seasonal fluctuations and abundance of the three species of *Sagitta*, namely *S. bedoti*, *S. inflata* and *S. pulchra* collected from the Cochin backwaters have been studied. A comparative study of *S. inflata* of the estuarine and marine habitats has been made.

Investigations on the taxonomy of pelagic tunicates from the Indian Seas:

A systematic study on Salpidae and Doliolidae was conducted. A total number of 75 plankton samples were examined qualitatively. During

examination of V1 to V18 plankton collections, it was foud that the use of different gears has a bearing on the quality of salps and dolioids available in the collections. Eighteen species of salps were identified of which *Cyclosalpa-pinnata quadriluminis* Berner (1955) is a new record for the Indian Ocean. Fourteen species and one variety of doliolids have been identified from the Varuna collections, of which 5 are new to science. This includes a new genus represented by a single species and four new species representing the genera *Dolioloides*, *Doliolina*, *Doliolum* and *Doliopsis*. The description of these species is under preparation.

The gonozooid and phorozooids of *Doliolina sigmoides* Garstang (1934) have been identified. This species resembles closely with *Doliolina obscura* Tokioka and Berner (1958). Further investigations on the systematics of tunicates are in progress.

Investigations on the zooplankton of the inshore waters with reference to fluctuation of important species :

As usual, copepods and cladocerans were the dominant planktonic groups in the standing crop. Although *Penilia* and *Evadne* together retained the second position, they were not occurring in swarms as was noticed during the quarter ending 31st December 1968. Other important items were, echinoderm larvae, chaetognaths, decapod larvae, appendicularians and siphonophores. *Lucifer* also occurred in plenty in various stages of development. Fish eggs and larvae were common in February and April. The composition of the plankton distribution is shown in Table I.

During the second half year, regular plankton collections could be made only from October onwards. Zooplankton in general was poor during this period. Monthly averages are given in the following tables.

TABLE I

Zooplankton biomass during October, November and December

		Volume (ml)	Weight (mg)	Numerical counts (x1000)
Oct.	S:	14.6	775	299
	V:	0.4	100	14
Nov.	S:	14.2	1818	293
	V:	0.3	455	50
Dec.	S:	25.1	3740	277
	V:	1.0	607	38

TABLE II

Plankton distribution (Relative frequency)

	January		February		March		April		May		
	S	V	S	V	S	V	S	V	S	V	
Displ. vol ml	23.8	1.7	22.0	1.3	19.3	2.6	18.1	0.86	19.6	0.2	
Dry wt in mg	3180	480	3520	590	3890	690	3044	516	2910	280	
Total counts	163625	12531	175812	16348	161250	20875	170400	14000	329000	8500	
Copepods	75500	3344	106688	4688	86750	7688	99800	5350	119000	3000	
Penilia	17250	1250	4250	625	22875	2625	—	—	47000	500	
Evadne	12875	406	9000	188	5000	438	12800	1250	125000	500	
Echinoderm larva	20625	563	6000	2875	875	312	5000	1150	5000	500	
Chaetognaths	5625	375	4500	1312	10250	1375	11600	1600	8000	—	
Prawn larvae	4250	459	11750	536	1875	375	4600	1250	7000	500	
Crab larvae	3250	499	6500	437	2750	250	3800	100	1000	—	
Appendicularians	3625	125	4000	875	6750	1563	600	200	2000	500	
Ceratium	4000	3500	4750	1563	3875	2750	3600	1100	—	2000	
Siphonophores	3250	344	2500	250	7750	—	200	200	—	—	
Lucifer	2375	250	3250	438	10250	188	17600	800	8000	—	
Fish eggs & larvae	750	—	4125	125	125	—	7600	350	1000	500	
Others	5750	873	5249	1909	875	3061	3200	650	6000	500	

No Samples in June

The fluctuations in the values shown above were due to the changes in the composition of the plankton. The cladocerans *(penilia* and *Evadne)* were the most predominant members of the plankton in October and November. *Penilia* was in swarms as usual on many days during these months. In December their number decreased and copepods were in predominance. Fish eggs and larvae occurred in large numbers during October-November, while polychaete larvae and *Lucifer* were numerous during December.

Copepods as a whole were not so numerous during October and November but became dominant during December. The most important copepod was, as usual, *Temora turbinata* which occurred throughout the period of observation. Other important members were *Centropages, Acrocalanus, Acartia, Labidocera, Eucalanus, Oithona* and *Corycaeus.* Copepodites were very few.

Mangalore: Plankton at 4 fathom surface: Copepods were observed in good numbers during the months of January and February, but these were very few during April and May. Near "swarm" of copepods was observed during the second and third week of February. The dominant copepods were the species of *Paracalanus, Pseudodiaptomus, Acrocalanus, Temora* and *Corycaeus.* The other copepods present were *Acartia* sp., *Oithona* sp., *Euterpina* sp. and *Labidocera* sp. Copepodites and nauplius stages of copepods were observed throughout this period. The cladocerans *Evadne tergestina* and *Penilia aviostris* were present in small numbers throughout this period. A "swarm" of *Penilia* was noticed in the second week of February. The other zooplankton organisms present were fish eggs, *Lucifer hanseni* and its larval stages, cirripede larvae, bivalves and penaeid larvae. Copepods were observed in small numbers during this period. Species of *Acartia, Acrocalanus, Paracalanus* and *Temora* were predominant, whereas species of *Oithona, Schmackeria* and *Eucalanus* occurred only in small numbers. Copepod nauplii were extremely rare.

Cladocerans were observed in small numbers during October to December. A swarm of *Evadne* was seen during the last week of September.

Plankton from 8 fathom to surface: Copepods were observed in fairly large numbers throughout January–March quarter, but these were few during April and May. A "swarm" of copepods was noticed in the last week of March. Cladocerans, *Evadne* and *Penilia* were present throughout the first half year.

A swarm of copepods was seen during the last week of October, mainly consisting of *Temora turbinata.* In the month of November there was a swarm of cladocerans and dinoflagellates.

Bombay: Displacement volume of plankton was high during October and low during July. Monthly mean values were as follows:

July	2.5	Aug.	2.6	Sept.	4.6
Oct.	16.6	Nov.	6.6	Dec.	5.6 in ml.

In the samples collected from the fishing areas off Bombay, chaetognaths *(Sagitta inflata* and *S. robusta)*, decapod larvae and copepods were abundant. Siphonophores, salps, amphipods and Cladocerans were poorly represented. Among copepods, *Eucalanus subcrassus, Acrocalanus gibber, Centropages orsinii, Temora tubrinata* and *Acartia spinicauda* were abundant, while *Euchaeta wolfendeni, Centrapages dorsispinatus* and *Tortanus barbatus* were rare.

Plankton samples from Versova creek were fairly rich comprising mainly of the chaetognath, *Sagitta robusta*, mysids, copepods and fish larvae. The mysid, *Dactylomblyops* sp. was abundant in the samples throughout the period of observation, except in the month of December. Copepods were fairly rich in the plankton. Species like *Eucalanus monachus, Acrocalanus gibber, Acartia spinicauda* and *Oithona brevicornis* were abundant.

An interesting observation was the strict periodicity in the occurrence of the copepod, *Centropages dorsispinatus* which was present in the samples only during the months of September to November. During the previous years also this species appeared in the same months.

Port Blair: The analysis of zooplankton collected from Marine Bay, Port Blair revealed the following salient features:-

1. Swarms of copepods on 22-1-'69, 19-2-'69 and 25-6-'69, consisting of *Calanus, Pontella, Labidocera, Oithona, Temora, Pseudodiaptomus* and *Heterorhabdus* were seen.

2. Abundance of fish eggs on 21-5-'69 and 28-5-'69 was noticed.

3. Swarms of copepods consisting of *Calanus, Heterorhabdus, Labidocera, Pseudodiaptomus, Corycaeus* and *Pontella* on 9-7-69, 20-8-69, 5-9-'69, 29-10-'69 and 19-11-'69. were observed.

4. Swarms of euphausiids consisting of *Euphausia* and *Pseudeuphausia* on 27-8-'69 and 8-10-69 were seen.

5. Abundance of fish eggs on 16-7-'69 and 10-9-'69 was an important feature.

6. Abundance of zoea larvae on 3-7-'69 was another interesting feature.

Studies on fish eggs, larvae and juveniles of fishes of Madras coast:

Fish eggs occurring in plankton were of different types and attempts were made to rear the different developmental stages in order to identfy them

correctly. Fifteen types of fish eggs were recorded in the half-year period. Eight of them were identified as *Anchoviella* sp., *Thrissocles* sp., *Hilsa kanagurta, Selar kalla, Selar mate, Carangoides malabaricus, Saurida tumbil* and *Cynoglossus* sp. The fish eggs occurred in small numbers during the half-year period, with the exception of two types on 10 March. Still fewer types of fish eggs occurred in the plankton between March and June as compared to January and February.

Between January and March the shore seines were mainly operated and smaller or appreciable quantities (32-94 kg) of *Anchoviella* sp. and others like *Sardinella fimbriata, Thrissocles mystax, Letognathus* sp., *Gazza* sp., *Parexocoetus brachypterus* in small quantities were obtained. The *Anchoviella* catches with the shore seines in the first quarter were much smaller than those in the corresponding period of 1968. On some days of February *Parexocoetus brachypterus* was present in large quantities. During the period, April-June the boat seine *thunivalai* was employed and the catches included *Lactarius* sp., *Thrissocles* sp., *Opisthopterus tardoore, Leiognathus* sp., *Johnius* sp. and *Trichiurus* sp. During the half-year, on some days, nylon gill nets and cotton gill nets were used and species such as *Sardinella fimbriata, Hilsa kanagurta, Thrissocles* sp. and mackerel were caught. The quantity of juveniles of different species caught in the shore-seines was expressed as percentage of the total quantity of each species in different hauls. Thus the percentage of juveniles in the case of *Anchoviella heteroloba* showed a wide monthly fluctuation, from 60-100% in January, 0-62 % in February, 12-88 % in March, 0-77 % in April and 0 % in May. In the case of *Leiognathus dussumieri* the juveniles formed 40-62 % in January, while in March and April they formed 100 %. Juvniles of the mackerel, *Rastrelliger kanagurta* formed 25-100 % of the total quantity of mackerel catches in February.

Four types ot fish eggs *(Saurida* sp. *Selar kalla* sp. *Cynoglossus* sp. and *Tetrodon* sp.) were recorded during the second half-year period. Plankton samples were analysed for qualitative and quantitative studies. Swarms of *Noctiluca* sp. pelagic tunicates and and copepods were observed during the period. Phytoplankton bloom was seen during August, October and December. Percentage compositions of the juveniles and adult fishes of different genera occurring from August to December at Triplicane and Thiruvanmiyur landing centres were determined.

Plankton sorting programme:

During the first half year general sorting was completed, for 19 samples, of which, 10 were fractional and 9 complete. Fish eggs and larvae were sorted out from 70 samples and cephalopods also from 70 samples. During the second half year the plankton sorting staff was engaged in the re-labelling of the samples. The sorted samples were given printed labels; and the station data and other details were entered in printed registers.

Quantitative distribution of fish eggs and larvae off the west coast of India and the Laccadive Sea in relation to some hydrological factors:

Zooplankton samples collected upto April 1968 were examined for fish eggs and larvae and these were sorted from the samples and counts were made. Preparation of the charts showing the distribution and seasonal abundance of fish eggs and larvae is in the progress. Subsorting and identification of the fish larvae of commercially important species is being carried out with an object to study their occurrence and seasonal abundance.

EXPLORATORY FISHING

Exploratory fishing from R. V. Varuna off the west coast of India and the Laccadive sea:

This project was completed and a report was submitted in July, 1969. This report has since been published under the title "Exploratory Fishing by *R. V. Varuna*. The report is in three parts and deals with problems as outlined below.

Part I. Exploratory otter trawling surveys by R. V. *Varuna* and other vessels operating in association with *Varuna* from the continental shelf edge and the upper continental slope, of the south west coast of India (exploratory otter trawling surveys by R. V. *Varuna*, results of the exploratory trawling from the neritic deep waters and the upper continental slope by R. V. *Varuna* and other vessels operating in association with her; size of fishes and crustaceans in the trawl catch from the upper continental slope; potentially important invertebrates; occurrence of jelly fishes; average otter trawl catch in Kg/hr of trawling; estimation of population size; new findings on trawling grounds along the continental slope bordering the Wadge Bank and extending up to the Gulf of Mannar; some hydrological features of the shelf edge, and the upper continetnal slope).

Part II. Exploratory survey of the kalava fishing grounds on the south-west coast of India. (Exploratory fishing for kalava; nature of kalava grounds; details of fishing, perches and other species caught by handlines from the kalava grounds; estimation of the number of kalava grounds; areas of abundance of kalava along the south-west coast).

Part III. Exploratory surveys of the pelagic and oceanic fisheries of the eastern part of the Arabian Sea and the Laccadive Sea. (Pelagic and oceanic fisheries; exploratory drift-net fishing; purse-seine fishing for tunas; mid-water trawling and deep scattering layer (DSL) investigations).

These investigations have led to:-

1. The demarcation of three distinct bottom conditions at the depth range 75 to 450 metres, associated with which are evident by three types of demersal communities. These are characteristic of the depth zones 75 to

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These investigations have led to:-

1. The demarcation of three distinct bottom conditions at the depth range 75 to 450 metres, associated with which are evident by three types of demersal communities. These are characteristic of the depth zones 75 to

100 m; 101 to 179 m; and 180 to 450 m. The potential demersal fishery resources have been estimated separately for these three depth zones which are as follows:-

Depth Zone	Area (Sq Km)	Estimated total demersal fishery resource based on average catch rates *	Estimated potential sustainable yield at 60 %
Depth Zone - I (75 — 100 m)	11363	** 7542 tonnes	4525 tonnes
Depth Zone - II (131 — 179 m)	11916	32556 ,,	19539 ,,
Depth Zone - III (180 — 450 m)	20240	58891 ,,	35335 ,,
Total	43510	98989 tonnes	59399 tonnes

* Estimated average catch = 62.42, 256.87 and 273.65 Kg/hr of trawling for depth zones I, II, III respectively.

** From trawling grounds only. This will not include demersal resources such as 'Kalava' or perches found in Depth Zone - I.

2. The intensive surveys of *R. V. Varuna* of the south-west coast have thus very clearly indicated the existence of rich, potential resources of certain deep sea species of fish, prawns and lobster, along the shelf edge and in the upper continental slope, about which practically nothing was known before. Some of the recent findings of prawns and deep sea fishes show the inadequacy of our knowledge of the natural distribution of these deep sea forms. The well equipped and larger fishing vessels of the Indo-Norwegian Project have proved, within a short time, the potentialities of fishing, on a commercial scale, in the deep waters of the shelf edge and in the upper continental slope. These were undertaken on the basis of initial results obtained from the explorations of R. V. *Varuna*.

3. Although the existence of kalava grounds was known earlier, the importance of the present investigations lies in the fact that the surveys carried out have given an idea of the pattern of distribution of the kalava grounds on the south-west coast. For the first time sonar was used in our waters in conjunction with the echo-sounders with the result that a fuller knowledge of the location and distribution of the grounds is now available.

4. Purse-seining for tunas has been successful in neritic waters. With improved gear it is hoped that similar results might be obtained in oceanic waters.

5. Drift-net fishing has shown the abundance of two species of frigate mackerel, *Auxis thazard* and *A. rochei*, in the open ocean. Both these were formerly known to occur rather sporadically along the west coast. Another important finding was the presence of the oceanic squid *Symplectoteuthis oualaniensis* in schools. These were generally attracted at night by the lights on board. This is one of the commercially important species fished in the Pacific Ocean. There is need for collecting more information on the oceanic squids and exploring the possibilities of developing their fishery.

Demersal fishes of the deep neritic waters and their occurrence and abundance in relation to some hydrological factors:

Demersal fishes landed by the Indo-Norwegian Project and the Central Institute of Fisheries Operatives, as a result of trawling in the upper continental slope, were examined for qualitative studies.

R. V. Varuna Cruise No. 133. A special cruise of R. V. Varuna was undertaken to investigate the bottom contours of the continental slope off the Wadge Bank and the Tuticorin coast (Gulf of Mannar) and to find out whether suitable trawling grounds existed in the shelf edge and in the upper continental slope. The results of the cruise will be presented in a detailed report separately.

The charts correlating the sardine and mackerel fishery with the hydrographic feature were revised and modified for the purpose of publication.

Investigations on pelagic and bathypelagic fishes with special reference to their taxonomy distribution and egg potential:

Pelagic and demersal fishes obtained during the exploratory surveys of R. V. *Varuna* have been identified and lists of the demersal and pelagic species have been given in the report entitled "Exploratory Fishing by R. V. *Varuna*". Detailed investigations are being carried out on the following species: *Benthodesmas tenuis, Centropristis investigatoris, Chascanopsetta lugubris, Chlorophthalmus agassizi, C. corniger, Cubiceps natalensis, Epinnula orientalis, Lepidopus caudatus, Pseneopsis cyanea, Rexea prometheoides, Scyllium hispidum, Thyrsitoides marleyi, Antigonia rubescens, Trigla* sp. and *Ruvettus pretiosus.* The nomenclature of several deep water fishes needs revision and this is also being undertaken. Whenever suitable samples are available, some aspects of the biology of the species, especially food, maturity, fecundity, and spawning are also being investigated.

Studies on the flying gurnards (Family: Cephalacanthidae)

Investigations on the taxonomy, distribution and some aspects of the biology of the flying gurnards of the south-west coast of India have been

completed. Three species, namely *Dactyloptena orientalis* (Cuvier), *D. macracanthus* (Bleeker), and *Diacocus peterseni* (Nystrom) were recorded from this area. The last two species were found to occur in shoals and the females of both species were found to attain a larger size than the males. One large sample of about 500 specimens of *D. macrcanthus* was analysed. Their stomach contents showed that the fish was actively feeding on shrimps, especially *Leptochela robusta* and *Solinocera pectinata*.

The fecundity counts taken for *D. macracanthus* showed the following details:

No of specimens	Minimum No of Ova	Maximum No of Ova	Average count	No of ova/gm of Ovary wt
6	44955	60938	54600	29660

On the basis of ova diameter frequencies, it was found that both *D. macracanthus* and *D. peterseni* probably spawn several times. From the data obtained by trawling, the bathymetric distribution of these two species has been studied.

The maturity, fecundity, spawning and spawning grounds of some pelagic fishes:

To determine the spawning, distribution of maturity stages and other connected aspects, the ova diameter frequencies of the available material of two species of tunas, namely *Auxis thazard* and *A. rochei*, are being examined. Similar studies are also being undertaken for other tunas, namely *Euthynnus affinis*, *Katsuwonus pelamis* and *Sarda orientalis*. Counts for 15 ovaries of *A. thazard* and *A. rochei* have been completed.

STUDIES ON BENTHOS

Studies on the bottom fauna of inshore area:

Studies on the taxonomy of polychaetes are in progress. The reference collection of polychaetes in the Institute has substantially increased by the addition of 12 families, 36 genera and 58 species bringing the total as 47 families, 131 genera and 200 species. The additions of rare forms give some idea of the adaptive variation in this group. A new species *Micromaldane jonesi* has been reported from the Gulf of Mannar.

Further studies on the ecology of Sabellariidae, a group of sedentary Polychaetes, based on the collections from Mangalore, Cannanore, Calicut, Azhikode, Cochin, Quilon, Kovalam and Colachel on the west coast and from Tuticorin, Mandapam (Palk Bay and Gulf of Mannar), Nagapatanam, Madras and Waltair on the east coast of India gave further information on the interactions of the species of polychaetes with the marine benthic

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animal community. Such an information is important from the point of view of fishery resources as benthic animals form the food of demersal fishes.

PHYSICAL AND CHEMICAL OCEANOGRAPHY

Investigations on the distribution of nutrients:

The processing of the nutrient data for 552 stations obtained from 19 cruises and comprising 3029 observations has been completed and the distribution charts are being prepared.

Studies on average distribution of temperature, salinity and oxygen in the Arabian Sea and their relationship to oil sardine and mackerel fisheries:

The processing of the hydrographic data available from 1957 to 1968 has been continued for the determination of monthly averages of temperature, salinity, dissolved oxygen and sigma - T along the west coast of India. This is done to study the changes occurring in these parameters yearwise, monthwise and regionwise and to prepare and study the anomaly charts. The average distribution charts of the surface water properties and their relations with sardine and mackerel fisheries are being developed.

Observations on some hydrographical features off Gujarat and Maharashtra coast and the Angria Bank:

The processing and preparation of the distribution charts for the different parameters along the Maharashtra and Gujarat coasts have been completed. From the vertical distribution charts of May 1963, it has been found that off Porbandar the temperature is low near the coast than elsewhere. The thermocline is deep and lies between 75 to 100 meters. Off Bombay and Ratnagiri it is between 100 to 150 meters. The temperature increases towards south. Thus off Porbandar and Veraval, the temperature is 27.5°C and off Ratnagiri it is 30°C at the surface. More or less the same trend is seen in the sub-surface layers also. The northern regions show higher salinities (36.40 ‰) whereas in the region off Ratnagiri the salinity is 35.10 ‰. Dissolved oxygen content shows a uniform distribution throughout.

The processing of the Angria Bank data has been done and the preparation of the distribution charts of each oceanic property along the horizontal and vertical planes is being continued.

Studies on the nutrients and hydrological properties of the inshore waters:

Calicut: The hydrological and nutrient data obtatained during the year at Calicut showed that the monthly mean temperature values ranged from 30.10°C (in April) to 24.40°C (in September); pH values from 8.43 (in February) to 7.74 (in August); salinity from 35.05 $^{0}/_{00}$ (in April) to 32.29 $^{0}/_{00}$

(in October); dissolved oxygen from 4.11 ml/l (in March) to 1.6 ml/l (in September); total phosphate from 5.95 μg-at/l (in May) to 0.94 μg-at/l (in December); nitrite from 1.26 μg-at/l (in January) to 0.05 μg-at/l (in October); nitrate from 10.98 μg-at/l (in September) to 1.19 μg-at/l (also in September) and silicate from 35.44 μg-at/l (in December) to 8.40 μg-at/l (in January).

Mangalore: The surface temperature at 4 fathom station rose steadily from January to May and registered a peak during the second week of May. Hydrological data could not be collected during the monsoon months. In September the monthly mean temperature was 23.2° and thereafter temperature increased. The pH values range from 8.2 to 8.4 during the year. Surface salinity showed more fluctuations and its range was 28.84—34.18‰. The dissolved oxygen content ranged from 2.21 to 5.90 ml/l. The inorganic silicate content was low during the first half-year and became high from September to December. The phosphate values range from 0.1 to 0.48 μg-at/l.

Karwar: In all 236 samples were studied during the year; monthly average values were obtained (from observations at three stations) of different hydrological features. The values of temperature ranged from 30.60°C (in May) to 24 66°C (in September); pH from 8.44 (in November) to 7.98 (in August); salinity from 35.29 ‰ (in May) to 8.71 ‰ (in July); dissolved oxygen fram 5.16 ml/l (in February) to 0.93 ml/l (in October); inorganic phosphorus from 1.06 μg-at/l (in October) to 0.22 μg-at/l (in May); nitrite from 19.23 μg-at/l (in July) to 0.02 μg-at/l (in January) and silicates from 105.84 μg-at/l (in July) to 4.95 μg-at/l (in November).

Madras: Hydrological data were collected at three stations off the Madras coast. The consolidated monthly mean values show that salinity ranged from 36.51 ‰ to 24.51 ‰; dissolved oxygen from 5.76 ml/l to 3.91 ml/l; inorganic phosphorus from 2.27 μg-at/l to 0.80 μg-at/l; nitrite from 0.64 μg-at/l to 0. 24 μg-at/l and nitrate from 1.92 to 0.68 μg-at/l; silicate from 22.73 to 6.6 μg-at/l.

During the first six months of 1969, the salinity remained well below 35‰ although in the previous years maximum values for the corresponding period were above 35‰ which is usually the maximum for the given period of the year.

In nutrients there was not much difference from the previous year except that the maximum values for nitrate were slightly higher than those of the previous years.

The low values for salinity reflect the incidence of heavy rains in this region during this period and the discharge of freshwater from the Adayar and Cooum rivers into the inshors areas. Dissolved oxygen content was high during October to December. The pH was steady at 8.4. The values

of nutrients, excepting silicates, were some what erratic. It is worth noting that the nutrients are replenished from a near depleted state to their peak values during these months. Silicates on the other hand, showed an increase with the decrease in salinity during these months.

Port Blair: The average temperature of the water was lowest in January and highest in April. Similarly, the average salinity value of the surface water was lowest in January and highest in April.

The average value of temperature was fairly low and unifrom during July-September. It registered a sharp rise in October. A steady decline in the average value was noticed from November onwards. The average value of surface salinity was about the same during July and August. A slight decrease in salinity was noticed during September which was followed by a rise in October. Again a decline in salinity was noticed in November followed by a sharp rise in December. The temperature of the sea water at Marine Bay, Port Blair was unifom during July to September and showed a sharp rise in October. The maximum recorded temperature was 30.1°C.

On 23-10-69, and thereafter the temperature of the sea water showed a steady decline. The lowest temperature of 27.6°C was recorded during the last week of July and in the middle of September. The surface salinity was fairly low during July and high in August. A sharp fall was noticed during September followed by a small rise in October. The salinity was more or less uniform during October and November followed by a rise in December. The lowest salinity was recorded during the first week of September and November and highest during December.

Participation in the cruises of R. V. Varuna: Collection of samples and recording of data related to wind, temperature, depth, etc.,

There were only two cruises of R. V. *Varuna* during the first quarter. For the first cruise (No V. 133), 26 hydrographic stations were worked in 5 sections. Twenty six phytoplankton and 26 zooplankton samples were collected during this cruise. In the next cruise (No V. 134), 28 hydrographic stations were worked in 5 sections and 22 phyto – and zooplankton collections were also made. Trawling also was done at 12 stations in the first cruise.

Preliminary processing of the data was carried out which revealed the presence of low saline waters (S less than 34‰) above 50-75m depth in the Gulf of Mannar. The thermocline generally started at about 100-150 m and a well defined salinity maximum was conspicuous above the thermocline. The temperature in the mixed layer ranged from 26-28°c. and the dissolved oxygen content from 4 to 5 ml/1. These features were similar to those occurring along the west coast.

Analysis of data collected during earlier cruises:

The Sigma – T values for nearly 300 stations were computed from the pending work after incorporting corrections for temperature and salinity. Routine processing of the data is being continued. The processing of the data collected from the Laccadive region for the monsoon period of 1967 was also processed. The station position and charts have been prepared and the figures showing the distribution of hydrographical features are under preparation. The computation of Sigma – T values and specific volume anomaly values were also done. Analysis of the hydrographical features from the region, 0° to 8°N, between the meridians of 71° and 80°E (Maladive region), during September to October 1962 have been completed.

Hydrological studies at fishing stations off Bombay:

Water samples were analysed for salinity, dissolved oxygen and inorganic phosphate. Details of these analysis are given below:-

Surface temperature, showed a steady increase from January (23.2°C) to May (30.5°C). Monthly averages of salinity varied between 35.17‰ (January) and 32‰ (June). Low salinity values were recorded in June because of the onset of the monsoon season. Dissolved oxygen content during March was 4.13 ml/l. Inorganic phosphate content fluctuated between 0.41 μg-at/l in March and O.19 μg-at/l in May.

Lowest surface temperature was recorded in December (24.4°C) and the highest in October (29°C). The monthly averages of salinity varied between 25.5‰ in Augest to 34.7‰ in December. Dissolved oxygen values were relatively high during November (4.8 ml/l). Slightly higher values of inorganic phosphate were noted during September (O.62/ μg-at/l).

The monthly mean values of hydrographic data of Versova creek

Month	T°C	Salinity ‰	Oxygen ml/l	Inorganic Phosphate μg-at/l
July	27.3	28.78	—	0.23
August	27.3	25.2	—	0.27
September	26.8	34.3	—	0.42
October	27.1	34.3	—	0.34
November	27.7	34.5	3.89	0.38
December	25.9	34.7	4.4	0.43

At Floating Light House, Bombay

November only	28.1	34.5	4.8	0.23

Studies on equatorial waters based on the World Data Centre, Washington:

The oceanographic data obtained from the World Data Centre were processed to study the circulation of the equatorial weters in the Indian Ocean. Nearly 100 stations have been completed so far.

Studies on thermocline and its role in upwelling:

About 350 sea water samples for salinity and about 250 for dissolved oxygen content, were analysed and temperature data from about 100 stations were processed.

Analysis of temperatvre and salinity data off the west coast of India revealed that the prawn fishery was closely associated with the colder and denser waters which prevailed across the shelf during the south west monsoon. An upward shift of the thermocline was observed during that season indicating the occurrence of upwelling in these waters.

Investigations on water masses in the shelf and offshore region:

The processing of the data collected from the Maldive regions during the IIOE was undertaken. Four meridional sections were selected and the vertical distribution of hydrographic parameters such as temperature, salinity and dissolved oxygen was charted out. The observations were extended upto a depth of 3000—4000 m at different stations along with the latitudinal variation of hydrographic properties in that regions. The variation in the depth of thermocline, the position of the salinity maximum zone and the oxygen minimum zone in the vertical profile gave an idea of the water masses of a particular region in the Arabian sea.

The processing of the data collected from the Laccadive regions for the monsoon period of 1967 was also undertaken. The station position charts were prepared and the figures showing the distribution patterns are under the preparation. The computations of Sigma-T values and specific volume anomaly values were also done.

A theoretical approach was made on the possibility of obtaining zonal currents from geopotential fields by means of a single velocity scale. In this, a diagram by name "Theta-Cosphigram" was developed for studying the relative currents from the topography of the surfaces. Further studies on these lines are in progress.

Prawn fishery in relation to environmental factors in the Vembanad Lake:

During the first half year of 1969, cruises were undertaken in the Vembanad Lake to study the prawn fishery in relation to environmental factors of the Vembanad Lake. During the cruises, water samples from surface and bottom at twenty eight different stations and mud samples from ten stations and zooplankton and phytoplankton samples from some selected stations were collected. Penaeid larvae were absent in all the

samples. Water samples were analysed for salinity and dissolved oxygen. Salinity values showed an increasing trend from January onwards and reached its maximum in April with values ranging from 27.0 to 32.0 ‰. In the month of May the salinity values started decreasing. This decrease was due to pre-monsoon showers. The salinity reached a minimum of 0.5 to 3.5 ‰ in the month of June due to the heavy monsoon rains.

Similar cruises were undertaken in the lake during the next six month period. Water samples collected were analysed for salinity and dissolved oxygen. During the month of September almost freshwater occupies the entire Vembanad Lake. In October also the same condition prevails except for a few stations in Cochin and Azhikode areas where the surface water has salinity range 20.00 to 25.00‰. During November the salinity between Cochin and Azhikode and between Cochin and Vaikom ranges from 10.00 to 16.00‰ whereas near south of Thannerumukham the water is almost fresh. Except in Cochin-Cherai region, salinity shows an increases all along the lake during December.

It is hoped that these data will be correlated with the prawn fishery of the Vembanad Lake.

ANCILLARY MARINE RESOURCES INVESTIGATIONS

INVESTIGATIONS ON SEA WEEDS

Studies on the growth of marine algae in the Palk Bay and Gulf of Mannar:

Studies on the growth and fruiting of the algae were continued during the year. Data on the growth of *Sargassum myriocystum*, *Gracilaria follifera*, *G. verrucosa* and *G. llchenoides* were collected for one complete year and the maximum growth periods of these four algae were determined in different seasons of the year. Considerable variations were observed in the fruiting periods and the relative abundance of the vegetative, sexual and asexual generations of *Gracilaria*, *Gelidiella*, *Sargassum* and *Turbinaris* species, during the year.

Studies on density, distribution of agar and algin yielding sea weeds

Sample surveys were conducted in selected areas of the coast line to estimate the density of *Gracilaria crassa* occurring near Munakadu and Rameswaram and *Gracilaria corticata* and *Sargassum wightii* growing on the rocky near-shore areas of Mandapam and Pudumadom.

The mean density of macrophyte changed from place to place. For *Gracilaria crassa* the mean density in the localities surveyed varied from 2.9 to 3.3 kg/m^2. For *Sargassum wightii*, values varying from 12-14 kg/m^2 were obtained near Pudumadam; whereas highest values (19 kg/m^2) were obtained from the Mandapam area. The mean density values obtained for *G. corticata* near Mandapam and Pudumadam were 2.3 kg/m^2 and 5.3 kg/m^2 respectively. Further work on this project is in progress.

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851.	Mahadevan, S. and K. Nagappan Nair	1969	Distribution of coral reefs in the Gulf of Mannar and Palk Bay and their exploitation and utilization. *Ibid.*, January 1969, Abstracts, 14.
852.	Pillai, C. S. Gopinadha	1969	Stony corals of the seas around India. *Ibid.*, January 1969, Abstracts, 14-15.
853.	Rao, M. Umamaheswara	1969	Coral reef flora of the Gulf of Mannar, *Ibid.*, January 1969, Abstracts, 15.
854.	Silas, E. G.	1969	Investigations on the deep scatering layers in the Laccadive sea. *Ibid.*, January 1969, Abstracts, 16—17.
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STAFF POSITION

DIRECTOR : DR. S. JONES

I. FISHERY RESOURCES DIVISION

(a) *Fishery Survey* :

1. Dr. R. V. Nair, Senior Research Officer
2. Shri D. Chakraborty, Research Officer
3. Shri C. R. Shanmughavelu, Assistant Research Officer.
4. Shri S. K. Dharmaraja, Do.

(b) Fishery Statistics:

1. Shri S. K. Banerji, Senior Research Officer

II. FISHERY BIOLOGY DIVISION

(a) *Pleagic Fisheries:*

1. Dr. G. Seshappa, Senior Research Officer
2. Dr. M. S. Prabhu, Research Officer
3. Shri P. R. Sadasivan Tampi, Do.
4. Dr. K. V. Sekharan, Do.
5. Dr.V. Balakrishna, Assistant Research Officer
6. Shri V. Balan, Do.
7. Dr. P. Vijayaraghavan, Do.
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9. Shri K. Venkatanarayana Rao, Do.
10. Dr. B. T. Antony Raja, Do.
11. Shri D. M. Punwani, Do.
12. Shri P. T. Meenakshisundaram, Do.
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19. Shri A. Noble, Do.

(b) *Demersal Fisheries:*

1. Shri K. Virabhadra Rao, Senior Research Officer
2. Shri T. Tholasilingam, Research Officer
3. Shri V. Sadasivan, Do.
4. Dr. S. V. Bapat, Do.
5. Shri G. Venkataraman, Do.
6. Dr. B. Krishnamoorthi, Assistant Research Officer
7. Dr. M. Vasudev Pai, Do.
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13. Shri K. Venkatasubba Rao, Do.
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15. Shri P. Bensam, Do.

(c) *Crustacean Fisheries*:

1. Shri K. H. Mohamed, Senior Research Officer
2. Shri M. J. George, Research Officer
3. Dr. S. Ramamurthy, Assistant Research Officer
4. Shri M. S. Muthu, Do.
5. Shri M. Mydeen Kunju, Do.
6. Shri P. Vedavyasa Rao, Do.
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(d) *Molluscan Fisheries* :

1. Shri K. Nagappan Nayar, Research Officer
2. Shri S. Mahadevan, Assistant Research Officer
3. Dr. K. Satyanaraya Rao, Do.

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2. Dr. K. Radhakrishna, Assistant Research Officer
3. Shri P. V. Ramachandran Nair, Do.
4. Dr. M. Umamaheswara Rao, Do.
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(b) *Biological and Fisheries Oceanography:*

1. Dr. E. G. Silas, Research Officer
2. Shri C. Mukundan, Assistant Research Officer
3. Shri K. N. Krishna Kartha, Do.
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(c) *Physical and Chemical Oceanography:*

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2. Shri G. S. Sharma, Research Officer
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